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VOL. CXXXIV.—No. 3494] LONDON: FRIDAY EVENING, DECEMBER 15, 1922 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

INDIAN SERVICE OF ENGINEERS.

The Secretary of State for India in Council will, in 1923, APPOINT 11 ASSISTANT EXECUTIVE ENGINEERS for this Service if so many suitable candidates present themselves.

Every candidate must be a British subject or a ruler or subject of any State in India in respect of whom the Governor-General of India in Council has made a declaration that he is to be considered eligible.

European candidates who were of military age prior to November, 1919, must have served in His Majesty's Forces during the war, or have been prevented on adequate grounds from so serving. European candidates must have been born on or after 2nd August, 1895, and on or before 1st August, 1901.

Indian candidates must have attained the age of 21 and not attained the age of 24 years on 1st July, 1923, except that in the case of an Indian who has rendered service of the nature defined in the preceding paragraph, the same maximum age limit as for Europeans will apply.

Every candidate must either (1) have obtained one of certain recognised university degrees or other distinctions in engineering, or (2) have passed Sections A and B of the Associate Membership Examination of the Institution of Civil Engineers, or been exempted by the Institution from such examination, or (3) produce the required evidence that he is otherwise eligible under the regulations.

Applications from candidates must reach the India Office not later than 1st April. Printed forms, together with information regarding the conditions of appointment, may now be obtained from the SECRETARY, Public Works Department, India Office, Whitehall, London, S.W.1.

India Office, London,
11th December, 1922. 988

Building Inspector REQUIRED by the GOVERNMENT of the GOLD COAST for the Public Works Department for two tours of 12 to 18 months, with possible permanency. Salary £450 per annum the first three years of service, and then, if appointment confirmed, £510 per annum, rising to £720 by annual increments of £30, and thence to £800 per annum by annual increments of £40. Outfit allowance of £60 on first appointment. Free single quarters and passages. Liberal leave in England on full salary. Candidates, age 25 to 35, preferably unmarried, must have (a) a knowledge of the routine work of a Town or District Council Engineer's or Surveyor's office; (b) a practical knowledge of building construction; (c) a practical knowledge of town surveys; (d) a knowledge of the use of the theodolite and dumpy level and ability to plot own field work; and (e) preferably should be A.M.I.C.E. or hold equivalent professional qualifications.

Apply at once, in writing, stating age and giving brief outline of qualifications and experience, and stating whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/11,654. 1016

University of Cape Town.

CIVIL ENGINEERING DEPARTMENT.
ASSISTANT AND DEMONSTRATOR.

APPLICATIONS are INVITED for the POST of FIRST GRADE ASSISTANT AND DEMONSTRATOR in the Civil Engineering Department of the University of Cape Town. SALARY £350, rising by £25 per annum to a maximum of £450. An allowance of £40 will be made for passage money.

The duties of the post will include taking tutorial classes, assisting with the structural and design classes, preparing drawings, diagrams and cartoons, taking practical surveying, and generally carrying out the instructions of the head of the department. Applicants should have a good theoretical knowledge of engineering and be good draughtsmen and surveyors, and it is also desirable that they should have had some practical experience.

The successful applicant will be required to become a member of the University Teachers' Superannuation Fund and to take up his duties by 1st March, 1923.

Applications and copies of testimonials, all in duplicate, should reach the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar-square, W.C., from whom forms of application may be obtained, not later than the 31st December, 1922. 981

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for: THREE 10-TON STEAM TRAVELLING CRANES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 12th December, 1922.

A fee of £1 1s. will be charged for the specification, which will not be returned.

Tenders must be submitted not later than Noon on Friday, 22nd December, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
E. C. VOLKERS,
Secretary. 982

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for: 35-TON ELECTRIC TRAVERSER.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 11th December, 1922.

A fee of 10s. 6d. will be charged for the specification, which will not be returned.

Tenders must be submitted not later than Noon on Friday, 22nd December, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
E. C. VOLKERS,
Secretary. 985

City of Oxford.

RECONSTRUCTION OF BULSTAKE BRIDGE.

Oxford Corporation invite TENDERS for the RECONSTRUCTION of BULSTAKE BRIDGE. The work consists of a Pile Foundation and Concrete Superstructure.

Plans may be seen at my office, and specification, quantities and form of Tender will be supplied to responsible contractors on receipt of a deposit of £5 5s. The deposit will be returnable on receipt of a bona fide Tender.

Sealed Tenders, addressed to me and marked "Bulstake Bridge," may be delivered by 10 a.m. on Monday, January 1st, 1923.

The lowest or any Tender will not necessarily be accepted.

J. E. WILKES,
City Engineer.

City Engineer's Office,
Town Hall, Oxford,
12th December, 1922. 995

The Engineer

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PUBLIC NOTICES

Basford Union.

The Guardians of the Poor of the Basford Union invite TENDERS for the REMOVAL of the existing ECONOMISER and for the SUPPLY, DELIVERY, and ERECTION of a NEW ECONOMISER to specification and plan prepared by Mr. W. C. C. Hawtayne, M.I.E.E., Consulting Engineer, 9, Queen Street-place, London, E.C. 4, which can be obtained from the undersigned on deposit of Two Guineas, returnable on receipt of a bona fide Tender.

Tenders, in a sealed envelope, endorsed "Economiser," to be delivered to the undersigned not later than Twelve Noon on the 1st January, 1923.

HENRY STONE,
Clerk to the Guardians.

Public Offices,
Basford, Nottingham.
13th December, 1922. 1000

City of Birmingham.

TENDERS FOR PLANT FOR BROOKVALE-ROAD SALVAGE WORKS.

The Salvage and Stables Committee invite TENDERS for the SUPPLY and ERECTION of PLANT for REFUSE DESTRUCTOR and SALVAGE WORKS, now being erected at Brookvale-road, Witton, as follows:—

CONTRACT No. 1.—One 3-Wire Balancer Set and Switchgear for lighting purposes, and Two 110 K.W. Steam-driven Generating Sets, with Switchgear and Condenser.

CONTRACT No. 2.—One 3-Wire Balancer Set, with Switchgear and Charging Panels for Electric Vehicle Charging.

CONTRACT No. 3.—One Mechanical or Hydraulic Paper Press and One Scrap Iron Press, One Hydraulic Accumulator, and Two Sets of Pumps.

Plans and general conditions of contract (which include the Corporation's usual provisions as to labour and fair wages), may be seen, and copies of the specification and other particulars obtained, upon application to Mr. James Jackson, Superintendent, Salvage Department, 161, Corporation-street, Birmingham, on payment of a deposit of £1 1s., which will be refunded on receipt of a bona fide Tender.

Sealed Tenders, endorsed "Contract No. —," must be delivered at the offices of the Superintendent of the Salvage Department not later than Twelve Noon on Saturday, January 27th, 1923.

The Committee do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right to divide any contract between two or more contractors.

Contractors must state whether they have adopted the Government scheme for finding employment for disabled ex-Service men.

F. H. C. WILTSHIRE,
Town Clerk.

The Council House, Birmingham,
December 6th, 1922. 947

County Borough of Preston.

ELECTRICITY UNDERTAKING.
COAL AND ASH-HANDLING PLANT—E.P.S. 5.

The Corporation invite TENDERS for the SUPPLY, DELIVERY, ERECTION, and COMPLETION of COAL and ASH-HANDLING PLANT for the Ribble Power Station.

Specifications, drawings, and form of Tender may be obtained on application to the Town Clerk, Town Hall, Preston, on and after the 12th instant, on payment of a fee of £2 2s., which will be refunded upon receipt of a bona fide Tender.

Additional copies of the specification may be obtained from J. A. Robertson, Consulting Engineer, Brasennose House, 29, Brasennose-street, Manchester, upon payment of 10s. 6d., which payment is not returnable.

Sealed Tenders, endorsed "Coal and Ash-handling Plant," and addressed to the undersigned, shall be delivered at the Town Hall, Preston, not later than Twelve Noon on Wednesday, January 10th, 1923.

The Corporation do not bind themselves to accept the lowest or any Tender.

ALFRED HOWARTH,
Town Clerk.

Town Hall, Preston. 968

PUBLIC NOTICES

Manchester Corporation Waterworks.

THIRLMERE AQUEDUCT: FOURTH PIPE LINE.
NORTH AND SOUTH WELL VALVES, &c.

The Waterworks Committee invite TENDERS for the SUPPLY and FIXING of 56in. SELF-ACTING CYLINDER VALVES, 54in. and 56in. MANUAL CYLINDER VALVES, 52in. and 48in. OUTLET VALVES, &c.

Specification, form of Tender, &c., may be obtained on application to the Secretary, Waterworks Offices, Town Hall, Manchester, upon payment of a deposit of Five Guineas, which will only be returned to the tenderer provided that he shall have sent in a bona fide Tender and shall have returned the documents and the drawings lent to him, the drawings to be unmarked. Further information, if required, may be obtained from the Waterworks Engineer.

Sealed Tenders, endorsed as directed, must be delivered at the Waterworks Offices, Town Hall, Manchester, not later than the 29th January, 1923.

By Order,
P. M. HEATH,
Town Clerk.

Town Hall, Manchester.
14th December, 1922. 1005

Metropolitan Water Board.

TENDER FOR THE SUPPLY OF WROUGHT IRON FENCING.

The Metropolitan Water Board invite TENDERS for the SUPPLY of approximately 2070 YARDS of WROUGHT IRON FENCING, to be delivered at Barnes Station, London and South-Western Railway.

Tenders must be made on the official forms, which may be obtained from the Chief Engineer, New River Head, 173, Rosebery-avenue, E.C. 1, on and after Friday, 15th December, 1922, by personal application (Room 155) or upon forwarding a stamped addressed brief envelope.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1," and endorsed "Tender for Wrought Iron Fencing," must be delivered at the offices of the Board not later than 11 a.m. on Tuesday, 2nd January, 1923.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Acting Clerk of the Board.

Offices of the Board,
New River Head,
173, Rosebery-avenue, E.C. 1,
11th December, 1922. 987

The South Indian Railway Company, Limited, are prepared to receive TENDERS for the SUPPLY of:—

1. STEEL RAILS and FISH-PLATES.
2. SPARE PARTS for LOCOMOTIVE ENGINES.
3. COPPER TUBES, BRASS SHEETS, &c.
4. INDIA-RUBBER GOODS.
5. STEEL WORK for BRIDGES, Tinnevelly-Tiruchendur Railway.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tenders for Steel Rails and Fish-plates," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 29th December, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of Specifications Nos. 1 and 2, and of 10s. for each copy of Specifications Nos. 3, 4, and 5.

Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1,
12th December, 1922. 1004

PUBLIC NOTICES

Midland Great Western Railway of Ireland Company.

SLEEPERS.

The Directors of the above-named Company are prepared to receive TENDERS for the SUPPLY of 60,000 SOFT WOOD SLEEPERS, 9ft. by 10in. by 5in., delivered, either free on our wagons, North Wall Extension, Dublin, or L.O.S. Liffey Junction.

Full particulars, specification, and Tender form can be had on application to the Company's Chief Engineer, Broadstone Terminus, Dublin.

Tenders, endorsed "Tender for Sleepers," to be forwarded, addressed to the Chairman, Broadstone Terminus, Dublin, so as to reach him not later than 10 a.m. on Monday, 1st January, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

PERCY A. HAY,
Secretary.

Broadstone Terminus, Dublin,
8th December, 1922. 970

Midland Great Western Railway of Ireland Company.

STEEL RAILS AND FISH-PLATES.

The Directors of the above Company are prepared to receive TENDERS for the SUPPLY of 3000 TONS of STEEL RAILS and corresponding FISH-PLATES.

Specification, giving all particulars, can be had on application to the undersigned.

Tenders, sealed and endorsed "Tender for Rails," to be forwarded, addressed to the Chairman, Midland Great Western Railway, Broadstone Terminus, Dublin, so as to reach him not later than Monday, 1st January, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

PERCY A. HAY,
Secretary.

Broadstone Terminus, Dublin,
8th December, 1922. 969

State Electricity Commission of Victoria.

TENDERS FOR PLANT.

TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.

Copies of Tender form and specification may be obtained or inspected upon application to—

Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.

SPECIFICATION No. 22/0.—ASH and DUST EXTRACTION PLANT.

CHARGE.—£2 2s. for the first two copies of Tender form, conditions of contract and specification complete. This charge will be returned on receipt of a bona fide Tender. A third or any further copies will be supplied for the sum of £1 1s. each, not returnable.

PRELIMINARY DEPOSIT.—A preliminary deposit of £50 is required to be lodged with Tender.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m. on March 7th, 1923.

R. LIDDELOW,
Secretary.

State Electricity Commission of Victoria,
983 Melbourne, Australia.

Urban District Council of Windlesham (Surrey).

NEW SEWERAGE AND SEWAGE DISPOSAL SCHEME FOR BAGSHOT, LIGHTWATER, AND WINDLESHAM.
UNEMPLOYMENT RELIEF WORKS.
TO CAST IRON PIPE FOUNDERS.

The Urban District Council of Windlesham (Surrey) invite TENDERS for the SUPPLY and DELIVERY at Bagshot of about 330 TONS, more or less, of CAST IRON PIPES, varying in size from 3½in. to 15in. internal diameter; also a number of BENDS, TAPER JUNCTIONS, and other SPECIALS.

A copy of the specification and form of Tender may be obtained on application in writing to Major T. J. Moss-Flower, Civil Engineer, 28, Victoria-street, Westminster, S.W., and Carlton Chambers, Bristol, at his Bristol office, on and after 16th December, 1922, on payment of the sum of Three Guineas, which will be returned, provided a bona fide Tender be received and is not withdrawn before the acceptance by the Council of one of the Tenders.

Sealed Tenders, endorsed "Tender for Cast Iron Pipes," are to be delivered at my office at Bagshot by 4 p.m. on 29th December, 1922.

The lowest or any Tender will not necessarily be accepted.

Dated this 9th day of December, 1922.

By Order,
EDWYN T. CLOSE,
Solicitor and Clerk to the Council.

Council Offices,
Bagshot (Surrey). 1001

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PUBLIC NOTICES

Southborough Urban District COUNCIL. WATER MAIN.

The Southborough Urban District Council invite TENDERS for the PROVISION and LAYING of about 1500 Yards of 10in. CAST IRON WATER MAIN and 6in., 4in. and 3in. Connections to Existing Branches in the Main Road, Southborough, in accordance with the plans and specification prepared by the Engineers, Messrs. G. and F. W. Hodson, of Bank Chambers, Loughborough, and London.

Plans and specifications can be inspected at the Council Offices, Southborough, and schedules of quantities may be obtained from the Engineers on deposit of the sum of £5 5s., which will be returned after the receipt of a bona fide Tender.

Tenders, on the form provided, in sealed envelopes, addressed to the undersigned, must be delivered at the Council Offices, Southborough, on or before Thursday, 28th day of December, 1922.

The Council do not bind themselves to accept the lowest or any Tender.

PHILIP HANMER, Clerk to Council.

Council Offices, Southborough, 2nd December, 1922. 907

The Bengal and North-Western RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

30 BOGIE CARRIAGES (28 Third-class and 2 Compo. First and Second-class),

as per specification to be seen at the Company's offices.

"Tenders, addressed to the undersigned and marked "Tender for Carriages," are to be lodged not later than Noon on Monday, the 15th day of January, 1923.

For each specification a fee of £1 will be charged, which cannot under any circumstances be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board, E. A. NEVILLE, Managing Director.

237, Gresham House, Old Broad-street, London, E.C. 2. 12th December, 1922. 998

The Windlesham Urban District COUNCIL (SURREY).

BAGSHOT, LIGHTWATER AND WINDLESHAM SEWERAGE AND SEWAGE DISPOSAL WORKS. CLERK OF WORKS

(To commence duties at an early date).

The Council invite APPLICATIONS for the above APPOINTMENT. Candidates must be thoroughly experienced in the Construction of Modern Sewage Disposal and Drainage Works, and be able to efficiently discharge the duties required of Clerk of Works on works of this kind, and must be competent with the use of the level and theodolite and be able to set out and measure up works and keep accounts, &c.

No others need apply.

Preference will be given to qualified ex-Service men.

The Clerk of Works will be required to act under the direction of Major T. J. Moss-Flower, the Council's Consulting Engineer, and to devote the whole of his time to the duties of his office.

Salary £5 per week.

Time about 15 months, subject to approved service, and the engagement to be terminable by a month's notice on either side.

Applications, marked "Clerk of Works," stating previous experience and enclosing copies of three recent testimonials, to be sent direct to the Engineer, at his Bristol Office, Carlton Chambers, Baldwin-street, Bristol, so as to reach him not later than Noon on Thursday, December 28th, 1922.

By Order, EDWYN T. CLOSE, Solicitor and Clerk to the Council.

Council Offices, Bagshot, Surrey, 9th December, 1922. 979

SITUATIONS OPEN

THE CHATWOOD SAFE CO., LTD., Bankers' Engineers, Bolton, desire to advise all applicants for the position of Assistant to the Technical Director recently advertised, that the appointment has been made.

As the applications were rather overwhelming, they find it impossible to extend the courtesy of a personal reply. 958 A

WANTED, a Trained ENGINEER with Practical experience in Designing, Fitting-up and Running Steam Engines of the Central-Exhaust and Extraction Types and with general engineering knowledge.—Address, stating age, previous experience and salary required, P6587, The Engineer Office. P6587 A

WANTED, Good Keen MEN with Shop Experience for Writing Out Material Specifications; good opportunities for right type of man; must be accurate and quick.—Address, stating age, experience and salary required, 991, The Engineer Office. 991 A

WANTED, Smart Capable MAN to REPRESENT FIRM specialising in the Manufacture of Ships' Cooking Apparatus; only those with good practical experience in this class of work will be considered. State age, experience and salary required.—Address, P6580, The Engineer Office. P6580 A

ADVERTISING MAN, with Experience in Engineering Publicity, Copy Writer and Catalogue Layout; room for originality and initiative in large engineering firm. Only experienced men needed.—Address, stating experience and salary required, 1010, The Engineer Office. 1010 A

ASSISTANT REQUIRED for Advertising Department of large firm of Electrical Engineers and Manufacturers; previous Advertising Experience and Technical Engineering Knowledge essential. State age, experience and salary required.—Address, 973, The Engineer Office. 973 A

LOCOMOTIVE ENGINEER REQUIRED, with an established connection among locomotive superintendents of British railways and consulting engineers of foreign railways, to Push Sale and Conduct Negotiations for very important improvements for Steam Locomotives.—Address with full particulars of past experience, age, qualifications, salary required, &c. 992, The Engineer Office. 992 A

REQUIRED, the SERVICES of a Thoroughly Competent CLERK OF WORKS for a period of about eighteen months, at an inclusive salary of £400 per annum, to Superintend the Construction, in the South of England, of a Sand Filter Bed, about half an acre in area, Covered Service Reservoir with Reinforced Concrete Roof, to hold about 2½ million gallons, and Incidental Works.

Applications, which must be delivered not later than the 1st January, 1923, must be made on a special form provided for the purpose, which will be forwarded upon application.—Address, 978, The Engineer Office. 978 A

SALES MANAGER WANTED by Makers of Small Oil Engines and Electric Lighting Sets, with growing trade. Preference given to gentleman able to make small financial investment to qualify for directorship and take over entire commercial organisation of firm. Full details upon all points, including previous experience and results obtained at home and abroad, should accompany application.—Address, P6589, The Engineer Office. P6589 A

SEVERAL Capable and Energetic SALESMEN REQUIRED, with knowledge of Tubes, Fittings and Supplies for Engineering, Heating and Sanitary Trades. Real live men only need apply. State age, full particulars of past situations, salary required. Unless these particulars are given, application will not be considered.—Address, 964, The Engineer Office. 964 A

SITUATIONS OPEN (continued)

WANTED, a DRAUGHTSMAN, Experienced in Hydraulic Machinery and Cranes. State age, experience, references, and salary required.—Address, 940, The Engineer Office. 940 A

WANTED AT ONCE, for London Office, Fully qualified STRUCTURAL DRAUGHTSMAN; one with experience in Mineral-handling Plants an advantage; progressive position assured for right man.—Address, giving age, particulars of experience, and salary expected, 1015, The Engineer Office. 1015 A

WANTED by a Leading Firm of Engineers in the North, engaged in Heavy High-class Engineering, a thoroughly capable DRAUGHTSMAN to act under the Chief, but to be entirely responsible for the quantity and quality of work turned out by the men under him. A man of character and ability would be well paid and have a comfortable and improving permanency.—Address, giving fullest particulars of training and experience, which will be treated in strictest confidence, 980, The Engineer Office. 980 A

WANTED by Leading Firm, SENIOR DRAUGHTSMEN, with first-class experience for Lay-out and Detail Work on Switchgear; none but first-class men need apply.—Address, stating age, experience and salary required, 990, The Engineer Office. 990 A

WANTED, Good SENIOR DRAUGHTSMAN with Lay-out Experience on Electrical Side of Central Stations. Age, salary, and when disengaged.—Address, 854, The Engineer Office. 854 A

WANTED in London, CHIEF DRAUGHTSMAN, experienced in all classes of Elevator and Conveyor Work.—Write, stating age, experience and salary required, to "M. W.," c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 984 A

WANTED, MECHANICAL DRAUGHTSMAN, Used to Colliery Plant and Buildings.—Apply, BARBER, WALKER and CO., Ltd., Harworth Colliery, Bawtry, Yorks, stating age, experience and wages required. 1011 A

WANTED, SENIOR DRAUGHTSMAN, Used to Standardising A.C. and D.C. Motors; Manchester district. State age, experience, salary, &c.—Address, 1009, The Engineer Office. 1009 A

WANTED, SEVERAL SENIOR SWITCHBOARD DRAUGHTSMEN.—Apply, stating age, experience and salary required, to BRITISH THOMSON-HOUSTON CO., Ltd., Drawing-office, Willesden, N.W. 10. 1021 A

ASSISTANT DRAUGHTSMAN REQUIRED, Paraffin-Petrol Engines, Marine and Industrial; South Coast. State age, experience and salary in confidence.—Address, 994, The Engineer Office. 994 A

DRAUGHTSMAN for Structural Steelwork REQUIRED, Midlands district. State age, wages and experience.—Address, 993, The Engineer Office. 993 A

DRAUGHTSMAN REQUIRED, Familiar with the Design and Lay-out of Boiler-house Plants, Water-tube Boilers, Chain Grate Stokers, Coal and Ash-handling Machinery, &c.—Address, stating age, experience, references, salary, 996, The Engineer Office. 996 A

DRAUGHTSMEN, SENIOR, for Handling Plant and Cranes.—Address, stating age, experience, wages required, when free, 971, The Engineer Office. 971 A

DRAUGHTSMAN WANTED, Accustomed to Condensing Plant Details and Power Station Lay-out; good opening.—Address, stating age, particulars of experience, and wages expected, 986, The Engineer Office. 986 A

DRAUGHTSMAN WANTED by Important Firm in the Midlands manufacturing Steam Engines and Pumping Machinery. Applicant must have had shop training and wide experience.—Address, full particulars, stating age and salary, 1008, The Engineer Office. 1008 A

GOOD DRAUGHTSMAN, Specialised in Switchboard Work, REQUIRED. Must have had good mechanical training. State age, experience, and salary.—Address, 969, The Engineer Office. 969 A

LEADING DRAUGHTSMAN WANTED, Fully experienced Railway Carriage and Wagon Work, Steel Car Designing knowledge preferred. Age, experience and salary.—Address, 999, The Engineer Office. 999 A

MACHINE TOOL DESIGNER WANTED for Special Tools. Applications are only invited from men of first-class ability. Reply, giving qualifications.—Address, "DESIGNER," Wm. Fortescue and Co., Advertising Agents, Glasgow. P6575 A

MECHANICAL DRAUGHTSMEN REQUIRED for the Design of Mechanisms. Only good men with Shop Experience need apply. State age, salary and experience.—Address, 972, The Engineer Office. 972 A

WANTED, ESTIMATING CLERK for Railway Rolling Stock. Experienced man only.—Apply, LEEDS FORGE CO., Ltd., Leeds. 914 A

ESTIMATOR-RATEFIXER REQUIRED, Used to Small Electrical Work for London works.—Address, stating age, salary and full experience, 1013, The Engineer Office. 1013 A

MECHANICAL ENGINEER or Good FOREMAN REQUIRED for Portuguese East Africa, to Take Charge of Upkeep of about 20 Locomotives and 2000 Wagons, 3ft. gauge. Age not over 40. Salary about £500 and house.—Write, Box "B. R.," c/o Davies and Co., 95, Bishopsgate, E.C. 2. 1002 A

SITUATIONS WANTED

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z, M. 613, c/o Deacon's, Leadenhall-street, E.C. 1006 B

CIVIL ENGINEER, Member Inst., good Linguist, wide experience railways, docks, irrigation and public works in general, SEEKS APPOINTMENT at home or abroad; good organiser and administrator. Salary not so much an object as active work.—Address, P6552, The Engineer Office. P6552 B

ENGINEER, Electrical, Mechanical, Civil and petroleum, 2 years Finsbury College, 5 years British Westinghouse, 7 years large cotton mill association, Manchester, 7 years important administration appointment large oil company, Persia, 1 year large contract work for same oil company, which now successfully completed, SEEKS SENIOR APPOINTMENT at home or abroad, preferably former; at present in England. Address, P6540, The Engineer Office. P6540 B

ENGINEER REQUIRES POST ABROAD; 14 Years' experience, single; technical education, 3 years oilfields abroad; experienced in I.C. and steam engines, boilers, turbines, pumps, knowledge electricity, construction and maintenance.—Address, P6585, The Engineer Office. P6585 B

ENGINEER, with 20 Years' Unbroken Experience, mass production, England, France, U.S.A., as demonstrator, tool designer, estimator, works manager, DESIRES SITUATION Production Engineer or Manager; good technical qualifications.—Address, P6591, The Engineer Office. P6591 B

SITUATIONS WANTED (continued)

ENGINEER, Young, Active, Capable, with Excellent commercial and technical training, first-rate education and address, proved salesman and organiser, SEEKS RESPONSIBLE POSITION on inside or outside staff; highest references.—Address, P6547, The Engineer Office. P6547 B

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For continuation of Small Advertisements see page 3.

Coal Wharf and Machinery of the North-Western Fuel Company of America.

No. II.*

CONSTRUCTION OF THE WHARF.

INTERESTING engineering features are included in this coal-handling and coal storage wharf, as well as in its mechanical equipment. The wharf is 500ft. wide and 1765ft. long. Its site is made land, formed in the shallow portion of Superior Bay, where the water was about 7ft. deep. Hydraulic dredgers excavated sand from the channel and slip and pumped it upon the site. The water side and end of the pier and the end of the slip are formed by timber cribs 26ft. wide and 28ft. high. These cribs are in lengths of 80ft. to 800ft. The construction is shown in Fig. 5.

For each crib a trench was excavated by a dipper dredger, the trench being made about 40ft. wide, with its bottom 2ft. below the elevation for the bottom of the crib. Sand was then placed to form a base or bed. Then the crib was towed into position and sunk upon this base by filling it with sand. When sunk, the top of the crib was far enough below low-water level to preclude any chance of the timbers becoming exposed to the air. Piles driven against the inside of the rear wall anchor the crib in place. In addition, there are inclined bracing piles placed inside and transversely to the line of the pier.

These large timber cribs, as shown in the engraving, are of horizontal timbers, 10in. by 12in., built up to form solid walls which are tied together at 9ft. intervals by transverse timbers of the same size, having their ends dovetailed into the walls. These transverse timbers do not form solid partition walls, but merely open partitions, and at these points the crib is stiffened by diagonal plank braces spiked to the transverse timbers. There is also horizontal diagonal bracing in the compartments.

At the ends of adjacent cribs are vertical timbers, so placed as to interlock when the cribs are in position, thus holding the two cribs in line and at the same time forming a stop or seal to prevent the escape of sand filling through an open joint. After the cribs had been placed, filled and anchored, a suction dredger pumped in sand to complete the filling of the cribs themselves and the space which they enclosed. This filling was left to settle during the winter, and the next season the surface was dressed to the required crown and elevation, from 6ft. above low water at the inner side to 5ft. at the cribs. The entire area of the pier was then covered with 2in. planking spiked to sills or sleepers embedded in the sand.

A massive dock wall of reinforced concrete—Fig. 5—surmounts the water side of the crib. It is supported on interior rows of foundation piles driven into the sand fill and is made with buttresses projecting on the inner side and resting on similar piles. The wall projects about 8in. beyond the face of the timber cribs, in order to protect the latter, and is itself protected against damage by ships by means of a fender composed of two lines of 60 lb. flange rails embedded in the concrete. The flanges of the rails are flush with the face of the concrete wall. Expansion joints are provided at intervals of about 160ft. Cast iron bollards or mooring posts are placed along the top of the wall, spaced 54ft. apart. To secure the wall in position diagonal rods embedded in the concrete are led back to anchor blocks on the rear wall of the crib.

For the travelling gantry or coal-handling bridge there are two lines of rails of 30in. gauge, spaced 342ft. between centres, as shown in Fig. 5. Flange rails of 100 lb. per yard are used. The line of rails along the front or water side of the wharf is laid upon the concrete dock wall. White oak sleepers, 8in. by 10in. in section and 6ft. long, spaced 24in. between centres, are partially embedded in the concrete, the top of which is crowned in order to shed water. Anchor bolts built into the concrete pass through the sleepers. The rails rest on ⅝in. steel base plates 10in. by 10in., and are secured by cast steel clip washers on ⅝in. screw spikes 7½in. long.

For the support of the inner or rear line of rails there is a massive concrete beam embedded in the sand filling and resting on three rows of piles which have a longitudinal spacing of 3ft. This beam, 1576ft. long, is 7ft. deep, and from 7ft. to 4ft. wide. It is made in 160ft. lengths between the expansion joints, the ends of the sections being shaped to form a mortice and tenon in order to prevent the lengths of the beam from getting out of alignment. Wooden sleepers are not used in this case, but the rails rest on ½in. steel plates or sleepers 3ft. long, which serve to maintain the gauge. These plates, spaced 24in. between centres, are 9in. wide under the rail joints, while the intermediate plates are 4in. wide. The rails are secured by clips and nuts on the projecting legs of U-shaped ⅞in. anchor bolts embedded in the concrete.

All the rail joints are made with special angle fish-plates which do not cover the upper part of the rail web. This arrangement is used to allow free passage for the jaws of the holding-down grips or rail clamps of the travelling bridge, these clamps sliding along under the rail heads. At the ends of each line of rails are concrete buffer stops faced with striking timbers or fenders. Thick mats or cushions of woven rope are placed between the fenders and the concrete blocks to reduce the shock in the event of the gantry bringing up against the buffers. As the gantry is operated by electric power the rail joints are bonded with copper.

ELECTRICAL EQUIPMENT.

Three-phase 25-cycle alternating current at 13,200 volts is delivered at a sub-station on the wharf by underground feeders from a transmission line of the Great Northern Power Company. This sub-station is equipped with the following Westinghouse apparatus:—(1) A nine-panel switchboard; (2) two 500 kilovolt-ampères, three-phase, 25-cycle oil-cooled transformers of 13,200–450 volts; (3) two synchronous rotary converters, 500 kilowatts, 600 volts continuous current, six-phase, 750 revolutions; (4) a set of impulse-gap electrolytic lightning arresters, 10,000 to 15,000 volts maximum, three-phase, four elements, placed in the high-tension room; (5) a manually-operated remote-control single-throw oil circuit breaker, 300 ampères, 23,000 volts, also placed in the high-tension room; (6) two 4500-volt oil circuit breakers for each rotary converter, manually operated and controlled by overload relays and the necessary current transformers. The circuit breaker for starting is of 600 ampères capacity, and the other for running is of 800 ampères. There is room for a third rotary converter, with transformers and the necessary apparatus.

All power circuits on the wharf are of 500-volt continuous current. Three-phase, 25-cycle, 220-volt alternating current is used for all lighting except upon the coal-handling bridge, where 100-volt current is used, as noted already. To step down the lighting current there is an oil-cooled Westinghouse transformer of 37½ kilovolt-ampères, 13,200 volts to 220–110 volts. Lamps of 110 volts are used to avoid having to install lamps in series. Flood lights and high candle-power lamps are employed for lighting railway lines, weighing machines and general outdoor illumination.

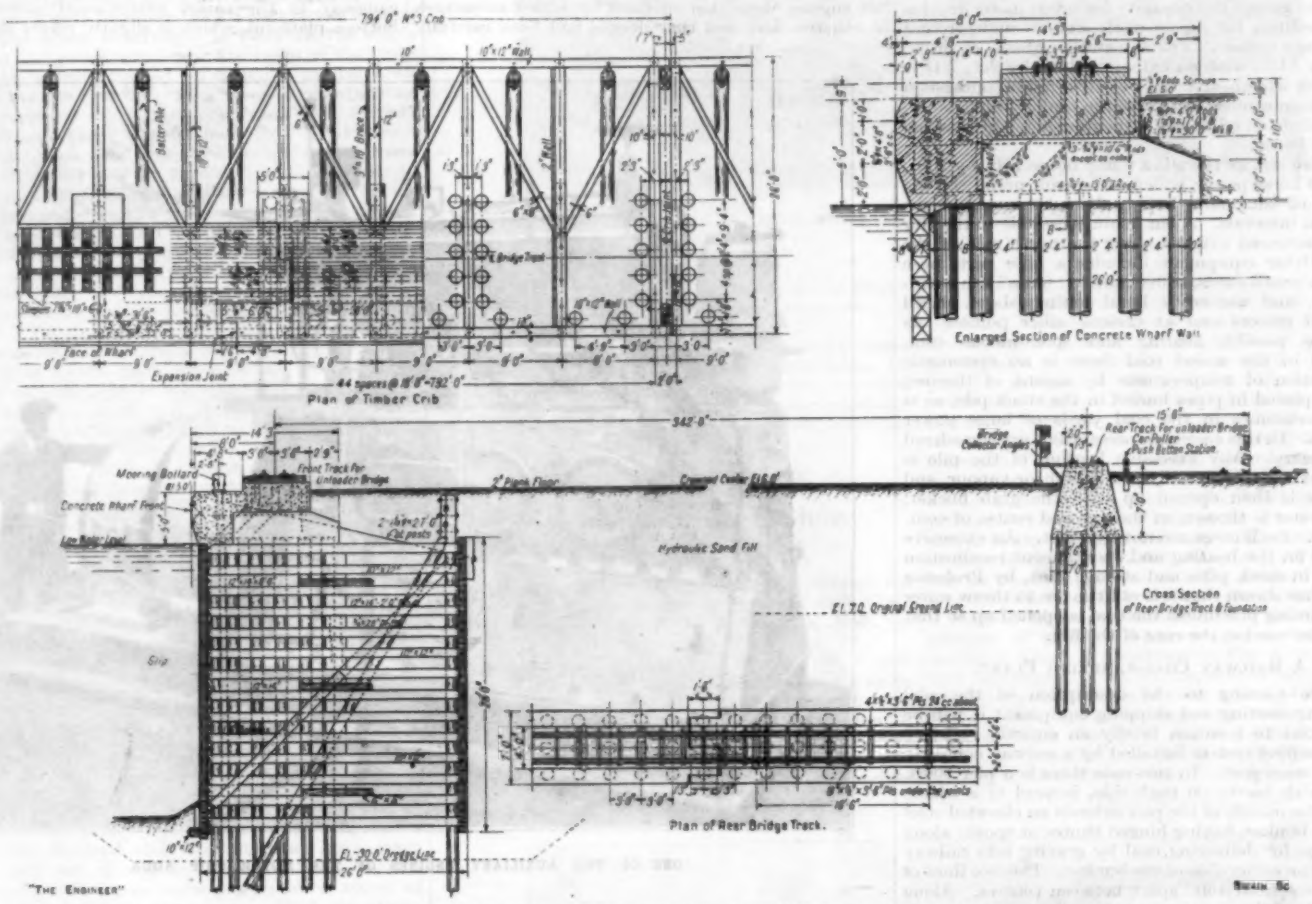

Plan of Timber Crib
Enlarged Section of Concrete Wharf Wall
Plan of Rear Bridge Track.
Cross Section of Rear Bridge Track & Foundation
"THE ENGINEER"

FIG. 5—CONSTRUCTIONAL DETAILS OF THE COAL WHARF AT DULUTH

RAILWAY LINES.

Three railway lines extend the entire length of the rear side of the wharf. The one nearest to the gantry rails is the regular loading line, on which two wagons—open or closed—can be loaded simultaneously. One of the wagons will be loaded with the larger sizes of coal and the other with one of the smaller sizes. Screenings may also be loaded into open wagons on the other two lines of rails by means of a 100ft. jib mounted on the coal-handling bridge and carrying a belt conveyor. A fourth line of rails runs between the face of the wharf and the anthracite storage shed. Extensive railway goods yards are closely adjacent to the wharf. All sidings on the wharf are laid with 85 lb. flange rails, tamarac sleepers being used on the straight and white oak sleepers with steel base plates and tie rods on the curves.

To shift the wagons into position on these rails there is an endless rope haulage system, the rope lying on either side of the middle line of rails. This rope is operated by a 50 horse-power electric reversing double-drum winding engine. The engine is controlled from push buttons fixed at seventeen points along the lines of rails, these buttons serving to start, stop and reverse the haulage rope.

* No. I. appeared December 8th.

For weighing railway shipments of coal there is a 150-ton railway scale or weighing machine, with a table 50ft. long, over a concrete pit which contains the weighing mechanism. This pit is waterproofed, lighted and ventilated. The weighbridge is placed slightly above the floor level of the wharf, so that wagons which are run upon it by their own momentum will pass off by the descending gradient and proceed by gravity along the rails. Point rails are inserted in the approach to the weighbridge, so that creeping of the rails will not extend to the table of the weighbridge. For weighing carts and motor trucks there are three sets of lighter weighing machines.

The driveways for carts and trucks are paved with 3in. maple planking. The entire floor of the wharf has a covering of 2in. maple planks spiked to 2in. by 6in. sleepers spaced 4ft. apart and embedded in the sand filling of the wharf.

BUILDINGS.

Apart from the structures for the coal-handling apparatus, the largest building on the wharf is the service building, containing the offices, rest room for the employees, a store-room, blacksmith shop and electrical repair shop. This building is provided with electric lights, steam heating apparatus, hot and cold water systems, sanitary drinking fountains, toilet rooms and shower baths, with connection to a city sewer. It is a brick structure, 30ft. by 90ft., with an extension 30ft. by 60ft. In front of it is the engine-house of the haulage or wagon-puller system. A well-equipped garage has capacity for seven motor trucks, with facilities for repair work and an underground oil storage system. The sub-station also is of brick, 28ft. by 54ft., with an extension 14ft. by 20ft. It is equipped with heaters and electric lights, and has a toilet room connected to a septic tank. Minor buildings include an oil house, carpenter shop and charcoal storage house.

For fire service there is a pump house 16ft. by 20ft., with 40 horse-power boiler and steam pump serving 1300ft. of 4in. main, having 2½in. hose connections at 200ft. intervals. A 6in. main accessible to the city fire department extends along the north side of the pier. Other equipment includes a hose cart, hose coils in small sheds, a five-gallon "foam" fire extinguisher, and numerous hand extinguishers placed near all motors and at various other points. As concerns possible heating and spontaneous combustion in the stored coal there is no systematic observation of temperatures by means of thermometers placed in pipes buried in the stock pile, as is done sometimes in the coal yards of large power stations. In this case such precautions are considered unnecessary. Any excessive heating of the pile is made evident by smell and smoke or vapour, and the pile is then opened up with the grab bucket, while water is thrown on the exposed centre of combustion. Such cases are not frequent. An extensive treatise on the heating and spontaneous combustion of coal in stock piles and storage bins, by Professor Stoek, has shown that it is of little use to throw water on a burning pile unless the coal is opened up so that the water reaches the core of the fire.

A RAILWAY COAL-HANDLING PLANT.

Before turning to the description of the coal screening, sorting and shipping equipment it will be of interest to mention briefly an entirely different coal-handling system installed by a railway company at this same port. In this case there is a pier 600ft. wide, with berths on each side, instead of a wharf. Along the middle of the pier extends an elevated steel storage bunker, having hinged chutes or spouts along the sides for delivering coal by gravity into railway wagons on either side of the bunker. The two lines of rails are spaced 46ft. apart between centres. Along each side of the pier, beyond the railway lines, travels a steel tower or gantry of 264ft. span and 54ft. height, beneath which is a stock pile.

Coal is unloaded from steamers by grab buckets travelling on the gantries. These buckets can deliver the coal on to the stock pile or into a hopper on the gantry, with a spout for loading railway wagons, or into another hopper, at a higher elevation, feeding a lateral conveyor or a jib at right angles to the pier and extending over the bunker. The conveyor belt delivers the coal into the small trucks of a double-line cable haulage system along the top of the bunker, so that coal unloaded at any point along the pier can be deposited at any desired position along the length of the bunker.

Ordinarily coal is dropped directly from the unloader buckets upon the stock piles. At some convenient time it is taken from these piles by the same buckets, to be transferred to the bunker or loaded directly into railway wagons for shipment.

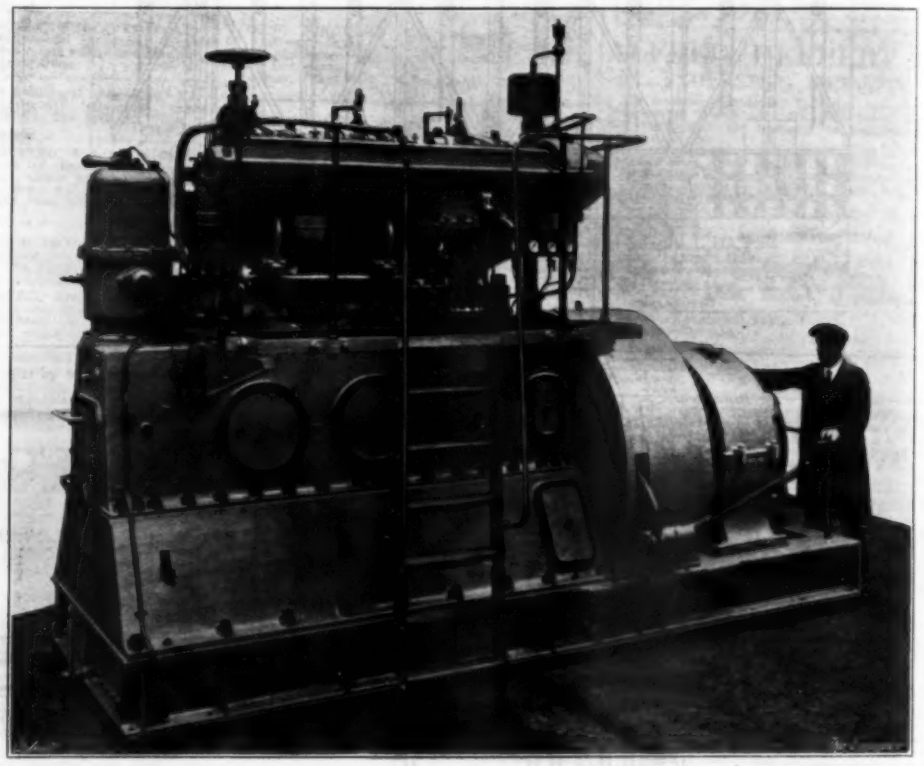
SOME two years ago French inhabitants of Madagascar drew attention to the fact that Madagascar was rich in radio-active minerals. Experts were sent to prospect and found that the Manandona region was rich in uranite (uranium phosphate), and that uranium oxide was found in the Ankaratra district. The working of these deposits has been begun, and last year 9 tons of uranium oxide were exported. Eighteen tons will leave Madagascar this year, and it is hoped that in the near future the island will be able to supply half the quantity of radium produced in the world.

The Elder Dempster Motor Liner Adda.

IN our issue of December 1st we gave a general account of this new motor liner which has now taken its place in the West African service of the Elder Dempster Company, and which bids fair to become still more popular than the Aba, the first motor liner which now has a record of a year's successful service. Having already described the ship, the passenger accommodation and the deck machinery, we now turn to the main engines and the auxiliary machinery equipment.

MAIN PROPELLING MACHINERY.

Experience has proved that extensive standardisation is an important factor in the manufacture of motor ship machinery, a factor which tends to reduce cost, and which makes for the complete interchangeability of parts which is a valuable asset to the shipowner. The record of the various ships built and engined by Harland and Wolff shows that engines on the Burmeister and Wain system of standard design and power may be installed with success in ships of varying type designed for different services, but that such standardisation is not incompatible with a steady advance in the design and construction of details and improvements in the machinery layout. Comparing the Adda with earlier ships, our impression was that her engines were characterised by added robustness in construction, and that details had been carefully studied with a view to convenience and reliability of operation. The engine-room is spacious and the machinery and auxiliaries are well arranged.



ONE OF THE AUXILIARY ENGINES OF THE MOTOR SHIP ADDA

In our previous description we referred to the commodious engineer's accommodation on the starboard side of the awning deck. Access to the engine-room is obtained from a working alleyway adjoining the engineer's quarters, in which the fan control room is placed and, in addition, the secondary lighting, the bilge pump and the settling tank controls. The engine-room entrance leads to the main top platform, which extends practically over the whole area of the engine-room, and gives complete access to the main cylinder covers and the valves and valve gear. The two main engines have each eight cylinders having a bore of 740 mm., and a piston stroke of 1150 mm., and the engines are rated for a combined normal output of 6000 indicated horse-power when running at a speed of 115 revolutions per minute. On page 636 we illustrate one of the engines on test. On the bulkheads immediately above the top platform are stowed spare valves and other parts, while in the centre of the platform itself we noted a bench equipped with two vices. Stools are provided for the valves and guides when changing or grinding in valves, and we were informed that provision has been made for the addition later of a valve grinding and seating machine, which has been designed and perfected by the engineer's department of the Elder Dempster Line, under the supervision of the Superintendent Engineer, Mr. J. B. Wilkie. There is overhead lifting gear which is capable of movement both fore and aft and athwart ships, and the design of the top platform is such that it will support two main covers complete with valve gear. The engine-room skylights may be lifted by means of a Bonlow hand-operated hydraulic device worked from the top platform. At the forward end of the engine-room the main exhaust pipes pass into the funnel where the silencers are placed. The waste heat from the exhaust gases is utilised for salt water heating, the gases then passing to the outlet pipes, which are fitted with spark arresters. The funnel also serves as a ventilating duct, and internal access from the engine-room is provided. We remarked that, although the exhaust mains were lagged, the covering did not extend over the expansion joint bolts, which were thus left free for adjustment. At the aft end of the engine-room at the top platform level are the two main fuel oil settling tanks which, in addition to the usual indicators, are fitted with electrically-operated cut-outs on the supply system and also low-level indicators. An engraving showing this platform looking forward is given on page 636. There is a separate fuel oil service for the auxiliary engines, which service is supplied from the main settling tanks.

The middle platform gives access to the cam shaft gear, and at both the forward ends this platform is extended around the tandem three-stage air compressors, which are integral with the main engine and are driven from an extended crank shaft. The arrangement of the platform at this part of the engine is such that access is possible to all compressor valves. Leading from the aft end of the second platform is a gangway to the raised switchboard gallery. The bottom platform, which is slightly raised above the engine-room main floor level, constitutes the main control station where the starting and control levers are arranged centrally to each engine. There is ample width between the two engines and the control platform is clear and free from any obstruction. The main switchboard, which we shall refer to again later, is in full view of the control station, and may be reached from the aft end of the bottom platform by an ascending stair, while a descending steps to the right and left lead to the Michell thrust bearings and the engine-room wings. The starting and control mechanism is of the standard type and embodies certain improvements. A small pump operated by hand is provided for the purpose of priming the fuel valves with oil before starting the engine, and a visible outlet is arranged near the control station so that the engineer knows when the valves are primed with fuel. During the operation of reversing an exhaust valve release device is automatically operated by the cam gear, which slightly relieves the pressure in the cylinders and assists the process of reversal. We noted that non-return valves were fitted on the air compressor delivery pipes, on the air injection pipe and on the fuel supply pipe close to the fuel valves.

At the forward end of the bottom platform are the main air injection receivers, two for each main engine, which are placed close to the compressors enabling a neat pipe arrangement to be carried out, while above the recess at the forward end of the engine-room is placed one of the three starting air receivers. This receiver is handy for port service, the two other receivers being placed over the auxiliary manœuvring compressors in the port wing. Other features of the

control and running platform which we noted were the series of long distance thermometers and pyrometers for reading exhaust temperatures, and an indicator showing which of the circulating pumps is in service, and an alarm bell attachment which operates in case of a possible failure in the cooling water service. Fresh water is used for piston cooling, it being passed through a special cooler in a closed circuit. The cylinder jackets are cooled with sea water, which is made to circulate through the piston water cooler before entering the jackets. The working parts of the engine, both internally and externally, are well illuminated by electric lamps, as is the space beneath the bottom platform around the engine bases where certain oil service tanks are placed. A large blackboard for the writing down of orders and the recording of readings is placed in a prominent position on the bottom platform, and it is, we are sure, of considerable service in the running of the plant.

AUXILIARY ENGINES.

The port side of the engine-room is wholly reserved for the auxiliary engines, which are four in number, and are Harland and Wolff standard three-cylinder units, designed to develop 150 brake horse-power at a speed of 300 revolutions per minute, coupled direct to Laurence-Scott 220-volt generators of 100-kilowatt capacity. The engraving given on page 624 shows one of these engines.

In our previous article we made reference to the emergency generating set which is accommodated in the steering gear house on the aft part of the awning deck, and which is arranged to carry on the ship's lighting and power services in the event of the main engine-room being flooded. This unit is similar in all respects to the four units in the engine-room, and as the emergency set is also connected to the main switchboard, there are, in fact, five 100-kilowatt generating sets. At first sight both the emergency set and the four sets for normal operation appear to give a very ample margin in power, as under ordinary conditions probably two generators fully loaded and, say, three when in port or when manœuvring, will supply all the power required, both by the engine-room and deck machinery; but the great advantage of having only one type of unit with a consequent reduction in the spare gear carried must not be overlooked. The four units are neatly placed in line, each with its own control gear. Overhead exhausts connecting to the main exhausts are fitted, and a special arrangement is adopted whereby a vapour collecting pipe from each crank case is led to a manifold with a breathing pipe up to the deck, any oil collected from the vapour being returned to the oil service tanks. The small number of spares necessary for the auxiliary installation makes it possible to carry one set of very complete spares, and we noted a piston complete with the connecting-rod and bottom end. The spare parts are grouped on the bulkheads near the engines. The main switchboard consists of eleven panels, each circuit being protected by a circuit breaker in addition to the usual switches and recording instruments. Alongside the switchboard are two 1 horse-power motor generators, which transform the pressure of the current from 220 volts to a low voltage suitable for operating the bells and telephones throughout the ship, thereby dispensing with the need of batteries.

PUMPS, COMPRESSORS AND REFIGERATING PLANT.

The starboard side of the engine-room is occupied by the two electrically-driven manœuvring compressors and the pump equipment. The compressors are of the Harland and Wolff standard three-stage type, and are driven by Laurence-Scott motors developing 180 brake horse-power, at a speed of about 250 revolutions per minute. With the exception of the three rotary gear-wheel type lubricating oil pumps and the fuel oil pump by the builders, the two motor-driven combined jacket circulating water pumps and sanitary pumps are by the Rees Roturbo Co. All the other pumps are of the Carruthers reciprocating type, and are driven by Laurence-Scott motors. They include the ballast pump, fire service pump, bilge pumps, piston cooling pumps, oil fuel pump, emergency bilge pumps and transfer pumps. Electrically operated turning gears are also provided. The refrigerating plant is by J. and E. Hall, Limited, and comprises two No. 9 CO_2 machines. The machines and coolers are accommodated in the forward recess of the engine-room, where the centrifugal brine pumps and a high lift brine pump, all electrically driven, are also placed. The temperatures of the various compartments are indicated by a series of Sentinel long-distance recording thermometers, by the Sentinal Instrument Company, Limited, of Newcastle. Immediately in front of the refrigerating plant and between it and the main engines is placed the auxiliary heating boiler, which is of the Cochran type, and is provided with twin Kermode burners. Although the cabin accommodation is fitted throughout with electro-vapour radiators, it is found that steam is indispensable for certain heating and cooking operations, especially the boiling of rice in large quantities necessitated by the native labour used on the West African services.

Another electrical device we noted in the engine-room was the anti-fouling equipment supplied by J. Stone and Co., Limited. There are also McNab indicators, which give a bridge reading of the direction and speed of each engine.

At the aft end of the engine-room is placed a series of tank gauges, which enable the engineer on duty to read the exact amount of oil in each double bottom compartment and in the deep tanks. This description would not be complete without mentioning the large well-lighted and well-arranged tunnel spaces for the propeller shafts. This space is separated from the main engine-room by means of a water-tight door, and in it are arranged the set of emergency bilge pumps with the necessary control valves. These pumps are motor driven and may be operated from the emergency generating circuit. Each section of the propeller shaft is supported by two large water-cooled bearings, and the spare length of shafting is carried in the peak space between the two shafts. An emergency exit leading to deck gives access to and from the tunnel space when the door leading to the engine-room is closed.

The Adda is a ship of which the owners and builders alike may be justly proud, and her performance on the run on which she has been placed will be noted with interest by all who regard the motor passenger liner as a permanent factor in the ocean-carrying trade of the future.

The Smithfield Club Show.

No. II.*

WE continue below our description of some of the exhibits at the annual Show of the Smithfield Club, which closed, at the Royal Agricultural Hall, on Friday, the 8th inst.

Robey and Co., Limited, Lincoln, had a new vehicle in the form of the six-wheeled steam wagon, shown in Fig. 9, which is capable of carrying 10 tons, and, in view of the fact that it is a self-contained unit, is permitted to travel at 12 miles per hour instead of the legal limit of 5 miles per hour for a wagon and trailer. We have already dealt with the standard Robey steam wagon, so little need be said about the front part of the new vehicle, as it is a steam wagon with the frames cut off short at the back. Between them there is bolted a large steel casting carrying a turntable, which, in turn, supports a swimmer ring attached to the body by means of pivot pins. The arrangement provides flexibility in both horizontal and vertical directions, so that the framing is not distressed in going over the hump of a steep hill, such as a canal bridge. Both the back wheels and the main driving wheels have brakes, operated by separate pedals, and the gear for the back brakes is connected up by means of a cable passing through the centre of the turntable, so that they may be equally effective regardless of the relative positions of the tractor and carrier. The transmission gear has two speeds, 6 and 12 miles per hour, the water tanks have a capacity of 165 gals., and the bunkers will hold 4 cwt. of coal. On the same stand there was one of the standard vertical Robey oil engines, which have been already described in THE ENGINEER, but fitted with a new type of blow lamp that works with crude oil and air at a pressure of about 30 lb. per square inch. We were told with this lamp the engine can easily be got under way in four minutes.

R. A. Lister and Co., Dursley, Ltd., Glos., showed a large variety of petrol and paraffin engines, among which there was a new model of 3 brake horse-power. This engine is equipped with a new form of vaporiser, which is said to be so effective that liquid paraffin never passes into the cylinder. Incidentally it gives a very high efficiency, and test results, which we have seen, show that the engine gives slightly more power when running on paraffin than it does with petrol. The consumption worked out at 0.585 pint of paraffin per brake horse-power per hour when the engine was developing 3 brake horse-power. It is started on petrol, and automatically takes up the load with paraffin as soon as the cylinder has warmed up.

The chief feature on the stand of Boulton and Paul, Limited, Norwich, was a water elevator working on the Caruelle system, which is a development of the old chain of buckets. The water is lifted out of the well in a series of little open ended cells that are riveted on to a continuous band. The band passes over pulleys at the top and bottom of the well, and is driven in any convenient manner. The net efficiency of these lifting bands is said to rise above 90 per cent., but as we hope to deal with the subject at greater length in the future, we will not enlarge upon it here.

Fodens, Limited, Sandbach, were showing a new pattern of their well-known steam wagon. This machine, which is illustrated in Fig. 8, is nominally of 6 tons capacity, but it is capable of carrying 7 tons and, at the same time, hauling a load of 5 tons in a trailer. The boiler of this new steam wagon is slightly larger than that of the 3 and 5-ton sizes. It has a specially large fire-box, 90 square feet of heating surface, and is worked at a pressure of 220 lb. per square inch instead of the original 200 lb. The cylinders have been increased to 4¼in. and 7in. in diameter by 7in. stroke, and the engine generally strengthened up to give about 18 per cent. more power. The transmission system remains much the same as before, and gives speeds of 4, 8 and 12 miles per hour. A departure from their usual practice has been made by the makers in adopting Ackermann steering gear in the place of a front axle turning on a perch bolt. There is, however, a front cross spring which gives a three point suspension. The driver and his mate have much more comfortable quarters than on the smaller wagons. There is, as will be seen from the illustration, a complete cab, with a door on either side. All the control levers are within easy reach of the seats.

Ruston and Hornsby, Ltd., Lincoln, had, besides the

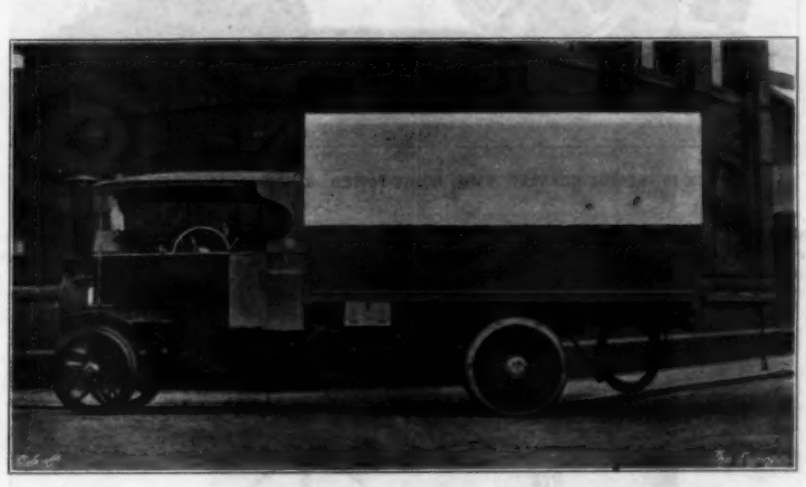


FIG. 8—FODEN SIX-TON STEAM LORRY

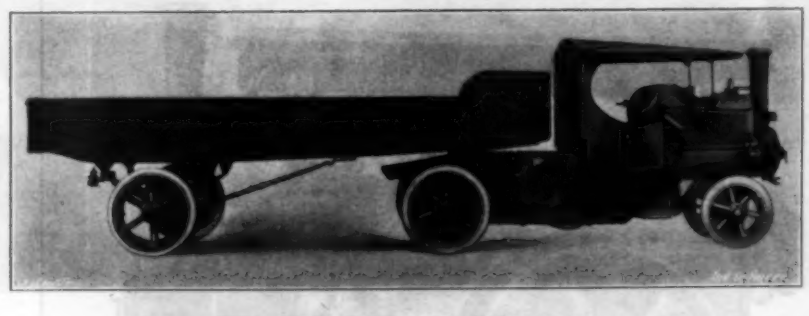


FIG. 9—ROBEY SIX-WHEELED STEAM WAGON

* No. I. appeared December 8th.

cold starting oil engine we have already referred to, the semi-automatic electric lighting set, shown in Fig. 10. It is driven by a 2 brake horse-power, hopper-cooled oil engine running at 500 revolutions per minute. The engine is started with petrol but runs on paraffin, and is comparatively easy to start, as it has a high-tension magneto of the oscillating type. The ¾ kilowatt dynamo is of the ventilated enclosed type, with self-contained automatically-controlled switch gear. The magnet frame, circular in form, is of cast iron, the main poles being of laminated iron and attached to the yoke by bolts, thus enabling the field coils to be easily removed. The regulating poles are forgings secured in a similar manner. The end shields are of cast iron, the one at the pulley end being provided with ventilating apertures and the other one at the commutator end having removable perforated covers allowing access to the brush gear. The commutator end shield is extended to form the case for the automatic control switch gear. The armature is of the slotted drum type, former wound. Carbon brushes are used, the brush holders being mounted on adjustable supports. Ball bearings are fitted at both ends. The terminals on the machine are enclosed but accessible. The switch gear fitted provides for starting and self-stopping with self-regulation of the lighting voltage during the charging of the battery. Tumbler switches and push buttons are provided for semi-automatic or hand-operation.

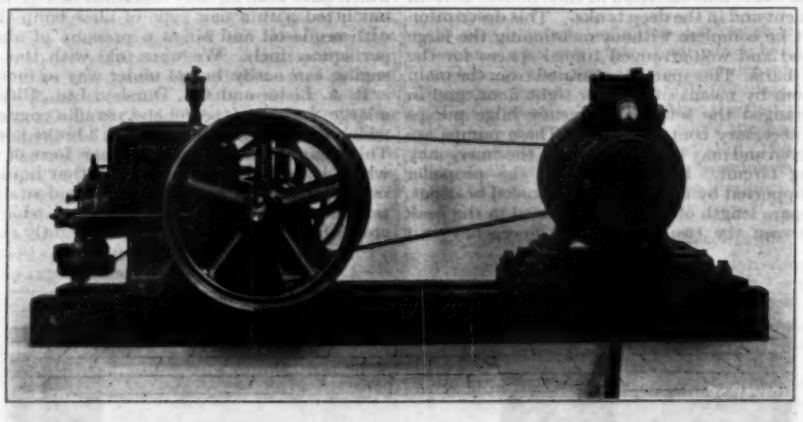


FIG. 10—RUSTON-HORNSBY TWO HORSE-POWER ELECTRIC LIGHTING SET

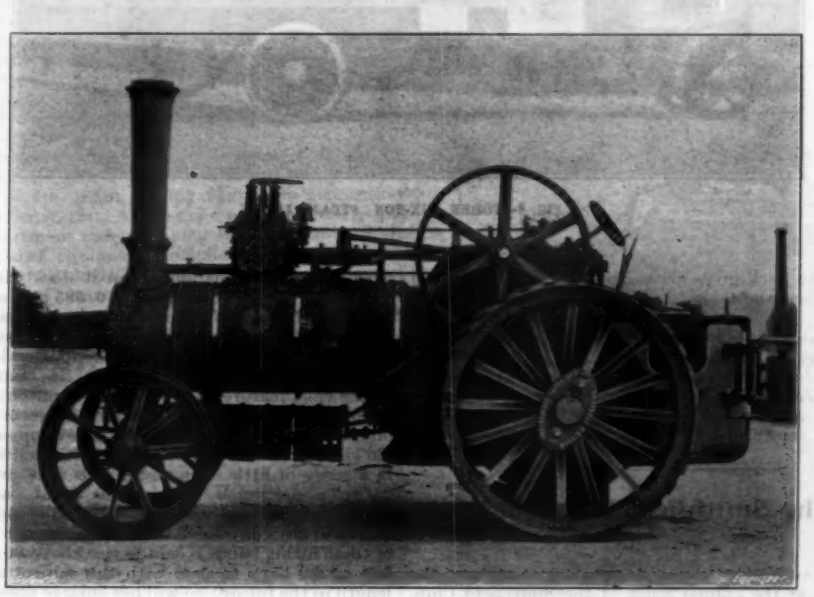


FIG. 11—WALLIS AND STEEVENS TRACTION ENGINE

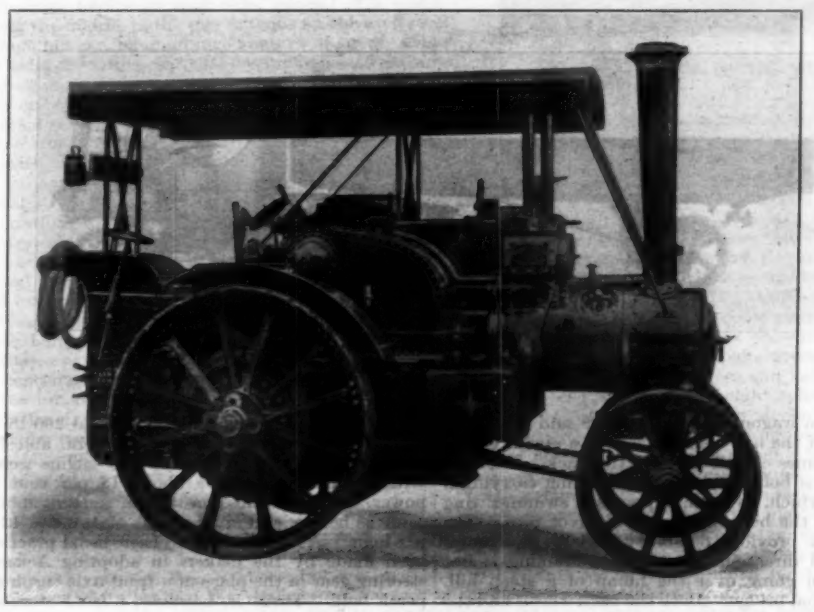


FIG. 12—TASKER STEAM TRACTOR

The Austin Motor Co., Limited, Northfield, Birmingham, exhibited its lightweight tractor, which has a 25 horse-power engine with four cylinders of 3¾in. bore and 5in. stroke cast *en bloc*, with a detachable head. The engine is started on petrol but runs normally on paraffin fed from a 10 gallon tank. Ignition is effected by means of a magneto, the lubrication by a gear pump and the cooling on the thermo-syphon system. There are two speeds and reverse, the forward speeds approximating to 2½ and 4 miles per hour, and a reverse of 2 miles per hour. The front axle is spring pivoted. The overall width is 5ft. 1in., the overall length 9ft. 2in., and the weight ready for work 28 cwt. A 24ft. circle is required for turning.

Among the exhibitors of milling machinery there were Barford and Perkins, Limited, Peterborough, and E. R. and F. Turner, Limited, Ipswich. The latter had a new mill, named the Turner-Macrot, which works on the attrition principle, and is intended for grinding maize in large quantities. It is made in three sizes with chilled iron plates 15in., 20in. and 24in. in diameter, which run in opposite directions at a speed of about 2000 revolutions per minute. The shafts run in ball bearings.

Charles Burrell and Sons, Limited, Thetford, and Wallis and Steevens, Limited, Basingstoke—Fig. 11—had traction engines of the types associated with their names; while W. Tasker and Sons, Limited, Andover, had a steam tractor—Fig. 12—with rubber pads on the driving wheels, and Wm. Allchin, Ltd., Northampton, showed a 4-ton steam wagon.

There were at the Show, of course, the usual makers of implements, such as J. and F. Howard, Bedford, Samuelsons, Banbury, and Barford and Perkins, Peterborough, together with hosts of manufacturers of dairy machinery, &c., too numerous to mention.

In connection with the notice of Messrs. Marshall's exhibits at the Show, which appeared in our issue of December 8th, the makers point out that while the fuel consumption we gave for their oil engines, of a trifle over half a pint per brake horse-power, is correct for the horizontal type of engine, the consumption of the vertical engine illustrated is slightly under half a pint per brake horse-power per hour.

Light Signals on American Railways.

In a report issued by the American Railway Signal Association it is shown that all the position-light signals introduced on the Pennsylvania Railroad have been changed from four lights to three lights in each row, spaced at 18in. centres. In this form of signal the rows of lights represent the respective positions of a semaphore arm. The signal as modified is satisfactory as to visibility, and effects a decided saving in cost of construction, maintenance and operation.

Construction cost is reduced owing to the fact that the large and unwieldy background formerly required—and criticised by many signal engineers—is replaced by a circle 54in. in diameter, so that it requires less clearance space than a semaphore. With this reduced size the wind pressure is lessened, so that standard signal masts are used instead of the former special 7in. and 8in. masts. Cost of maintenance is reduced by the elimination of three lamps in a three-position signal. Operating cost is reduced by the fact that the current consumption is reduced by 25 per cent.

Where primary batteries with approach lighting is employed the availability of the signal has been greatly extended, in that the cost of maintenance and operation is much less than that of a semaphore motor, if the approach lighting circuit is not occupied more than six hours per day. As a matter of fact, very few, if any, circuits are occupied more than two or three hours per day. Further, with the small current consumption, "tricklers" or small farm lighting outfits make the signals available as interlocking home signals. The lamps are 12-volt, 7½-watt, burned under voltage, and the total energy required for the three lamps lighted at any one time is 18 watts. For dwarf signals only two lamps are used in each row or position; they are 6-volt, 12-watt lamps, and the actual consumption is 16 watts. The current consumption is practically constant, so that there is no peak load as with motor-operated semaphore signals.

Among the advantages of these position-light signals are the following:—(1) Giving four positions—as against three positions for motor-operated semaphores, and three distinct colours in colour-light signals. (2) Saving of the waste of transmitting light through coloured lenses or roundels. (3) Elimination of dangers due to colour blindness. (4) Two lights must fail before a signal ceases to be distinctive. (5) Extinguishing of lights results in less favourable indications. (6) Elimination of moving parts reduces the possibility of improperly displayed "proceed" indications.

One-Lamp Colour-Light Signal.—In the same report is a description of a "single-unit" type of colour-light signal, recently put on the market, which uses only one lamp and lens for the three indications, thus considerably reducing the size and weight of the signal. The lamp is of the concentrated filament type, of candle-power suited to the required range, and is mounted in a special bayonet base in order to insure proper focus. A double filament may be used to guard against burnouts. An elliptical reflector with a highly polished silvered surface is used to secure the greatest possible utilisation of the candle-power available.

This use of a reflector, without danger of false indica-

tions, is made possible by the use of a single lens. Indications are changed by passing coloured roundels between the lamp and this clear lens. The roundels, which are mounted in the vane of the relay, are 1in. in diameter and 1/16in. in thickness. The outer lens of clear glass is 10¼in. in diameter and 6in. in focal length. It is of the Fresuel type, and is provided with a toric formation which gives a downward spread of light for short range indications. The standard lens provides for a spread of 8ft. in 100ft., but special lenses may be used for special conditions. The signal has a hood 15½in. deep, and a sheet metal background 3ft. in diameter.

A polyphase vane relay is used for alternating current operation. The vane and its counterweight are the only moving parts, and the whole movement is sealed in a metal case. The direct-current relay is constructed on the motor principle, no winding being used on the moving element, which is directly connected to the member carrying the roundels. The alternating and direct-current relays are interchangeable. The lamp is connected in parallel with the field winding in both alternating and direct-current signals, control of the indication being obtained by energising or de-energising a secondary winding. This mechanism is so designed as to drop by gravity to the red or "stop" position when de-energised.

For the three-position combination the relay mechanism is adjusted to a neutral control position to give the red indication. In explanation, the report points out that it is known that when the retina of the eye has been impressed with an image it retains this for a period of approximately one-sixteenth of a second. Since the mechanism changes the colour in a shorter period than this, the eye will retain the image of the yellow light or rays through the period which is consumed in passing through the red, and the eye will not readjust itself until after the green roundel has been reached. Thus the signal does not display a red light when passing from yellow to green, owing to the fact that the change is so rapid that the image of the red is not seen during its passage across the lamp.

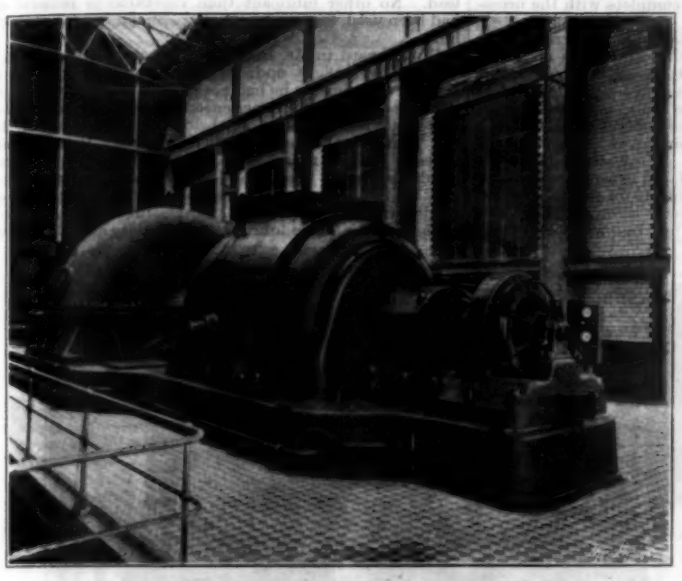


FIG. 1—10,000-KILOWATT TURBO-ALTERNATOR

FIG. 2—CONTROL ROOM

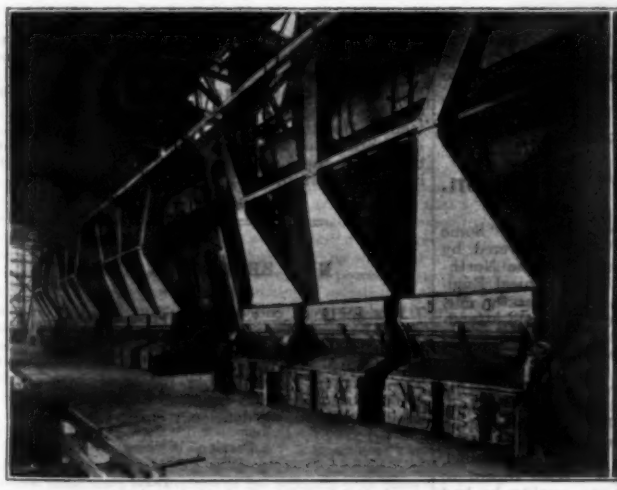


FIG. 3—INTERIOR OF BOILER HOUSE

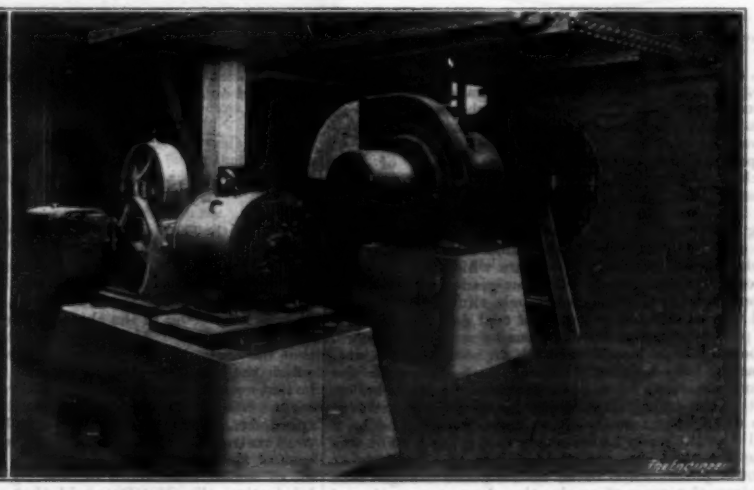


FIG. 4—MOTORS FOR MECHANICAL STOKERS AND FORCED DRAUGHT FAN

Electricity Supply at Leicester.

THE formal opening of a new electricity supply station at Leicester on the 8th of this month followed closely upon the completion of the first year in which the electricity supply department of the city of Leicester was governed by a committee separately appointed to control this important branch of the City Council's activities. The Corporation first undertook the supply of electrical energy in 1894, when the Aylestone generating station was erected on the gasworks site and supplied single-phase current, mainly for lighting purposes. The late Mr. Alfred Colson acted in the dual capacity of gas and electric lighting engineer and the controlling body was called the Gas and Electric Lighting Committee. This Committee remained in charge of the electric lighting department up to the end of 1910, when it was relieved of its duty by the Tramways Committee, which was then re-named the Tramways and Electricity Committee.

In the year 1904, however, the Tramways Committee had erected its own generating station at the Lero for the purpose of giving a direct-current supply to the electric tramways system which was established in that year. In 1908 the first serious attempt was made from this station, under the direction of Mr. T. R. Smith, to meet the heavy demand for power which was then rapidly developing in the city. Three years later, namely, in 1911, the electricity supply of the whole city was placed under the sole management of Mr. Smith, the city electrical engineer, and since that date the growth of the undertaking has been almost phenomenal. Extensions to the plants both at the single-phase station at Aylestone and at the Lero direct-current station soon became necessary, and three-phase alternators generating current at extra high pressure were installed in both those works. A new central sub-station was also erected in Newark-street for the economical conversion and distribution of current from the two stations to the ever-increasing number of lighting and power consumers as well as to the tramway system. So rapidly did the demand for current within the city increase that the capacity of the two stations soon became overtaxed, and as it was impossible to install additional plant on the two existing sites, a new station had to be constructed.

In 1917, Mr. C. H. Wordingham was called upon to prepare a scheme for extending the electricity supply system, and although the war prevented the projects being realised, a number of Mr. Wordingham's recommendations were ultimately adopted. At a later date the Electricity Committee decided to send its engineer to America for the purpose of studying latest practice in the United States, and the result of that visit is reflected in many ways in the design of the new central generating station which is situated on the Freemen's Meadow at Aylestone.

The site of this station is on the right bank of the river Soar. It is close to the main line of the Midland Railway and to St. Mary's-road, the position being very favourable for the delivery of coal by rail and water, and also for the supply and cooling of water for condensing purposes. The ground is well above flood level, and has a subsoil of deep gravel on a bed of shale rock, which forms an admirable foundation for the buildings and heavy plant. The main contract for the work, which was started in May of last year, was awarded to the English Electric Company, and included the boiler-house, turbine room, switch house and other buildings, the turbo-alternators, the electrical machinery for the auxiliaries, switchgear and important civil engineering works, the latter comprising the construction of the railway siding embankment 450 yards long, with extensions to the turbine room and wharf, the extension of St. Mary's-road, and the provision of two 60in. water intakes together with an open reinforced concrete discharge culvert between the power station and various points on the river.

The contract for the boiler-house equipment and the whole of the pipe work was awarded to Babcock and Wilcox, Limited, whilst the coal and ash-handling plant and wharf construction work was placed in the hands of the Mitchell Conveyor and Transporter Company, Limited. The portion of the new power station which has been completed accommodates a 10,000-kilowatt turbo-generator unit—as shown in Fig. 1—with the necessary steam-raising and auxiliary plant, but the building has been designed so that extension can be carried out at will until the total capacity of the plant becomes 65,000 kilowatts. A view of the boiler-house is given in Fig. 3, whilst Fig. 4 shows the mechanical stoker and forced draught motors.

As a result of the careful consideration given to the problem of cooling the circulating water, the fullest advantage has been taken of the facilities offered by the river from which the circulating water is drawn. Some 200 yards upstream from the power-house there already existed a substantial weir running diagonally across the river for a length of about 500ft., and the cooling effect due to the water running over this weir in a thin sheet and that due to the river itself has been utilised. A 60in. intake pipe has been led from the river bank at the far corner of the site into the screening pit, where there are two circular screens—see Fig. 5—and the water is then pumped through the condenser and out into the open discharge culvert, which runs from the power-house along the river bank to a point above the weir, where there is a larger open expanse of water.

Another intake designated No. 2 has been constructed approximately half-way between the weir and the No. 1 intake with the object of dealing with the water at flood levels when the difference in level between the two sides of the weir is slight. Under these conditions the circulating water is drawn through No. 2 intake, and after passing

through the condenser, discharges through No. 1 intake, which then becomes the discharge pipe. Valves in the waterways facilitate the operation of changing over from one system of working to the other. The scheme is said to be the result of extensive research work conducted on the site, and the investigations have shown conclusively that the cooling effect of the flow over the weir is sufficient to deal with perhaps 20,000 kilowatts of plant.

The coal is delivered to the site either by rail along the special siding which has been constructed or by river to a new ferro-concrete wharf 125ft. long by 35ft. wide. Rail-borne coal is unloaded by running each wagon into a "Mitchell Tippler," operated by a 10 horse-power motor. This coal-handling device consists of a cradle which rotates and carries the wagon with it until the latter is tilted at a sufficient angle to discharge its contents into a hopper underneath, the whole operation of tipping and returning the wagon taking less than two minutes. River-borne coal is unloaded by means of a grab crane into railway trucks, which are then dealt with in the tippler. From the underground hopper the coal is raised by means of a skip hoist to the upper part of the boiler-house, and is then distributed by a belt conveyor into the various bunkers.

The coal-handling plant and bunkers are of sufficient capacity to cope with the demands of the next set, which will be installed at a later date. In due course the coal passes from these bunkers through automatic weighers and down the chutes to the stoker feeder hoppers on the boilers, the quantity of coal which passes into each separate bunker being automatically recorded. The ashes discharged from the boiler grates fall into hoppers which are provided with doors which open into the ash "basement." This so-called basement is, however, as a matter of fact, at the ground level, so that the specially designed ash wagons, which run on a standard gauge, can be run underneath the hoppers to receive the ashes and transport them to the tipping position by means of a steam storage locomotive.

At present the boiler-house plant consists of four Babcock boilers having a capacity of 45,000 lb. per hour, the steam being generated at a pressure of 275 lb. per square inch, and being superheated to a temperature of 700 deg. Fah. Each boiler is fitted with an integral superheater and a superimposed steel tube economiser. The three chain grate mechanical stokers which are fitted to each boiler are designed to burn low-grade coal, which is fed from overhead bunkers through chutes fitted with control valves, and the quantity of coal used is measured at the port of entry to the furnaces by means of meters. Each boiler unit is also fitted with an instrument board. A separate forced draught—see Fig. 4—fan with the necessary air ducts have been provided for each boiler, so that it can be operated under balanced draught conditions when low-grade fuel is to be consumed, and on a natural draught when higher grade fuel is used. For this purpose the chimneys are divided into two portions at their lower portions and fitted with induced draught fans which draw the gases of combustion down one section of the chimney from the economiser outlet and discharge them upwards through the other portion of the chimney. Babcock and Wilcox, Limited, also supplied and fixed the whole of the main steam and auxiliary pipe work in the station.

The generating unit at present installed is shown in Fig. 1. The turbine which drives the 6600-volt 50-cycle three-phase alternator is of the impulse type. The air for cooling is obtained from a closed circuit air cooler which is placed immediately below the machine in the concrete foundations, together with a surface condenser, extraction pumps, circulating pumps, and so forth. After being condensed, the steam from the turbines is passed through pipe work which is arranged in accordance with the closed-feed system, so as to provide the boilers with pure water and at the same time to eliminate as far as possible scaling of the tubes. As is well known, this system has the effect of minimising the number of times the boilers have to be blown down, whilst the feed water is also kept as free as possible from air, which reduces the liability of trouble arising from corrosion.

A Prache and Bouillon automatic self-cleaning evaporating plant is provided for supplying distilled water at the rate of 3 tons per hour for the make-up feed. This plant consists of an automatic self-cleaning double condenser, preheater, thermo-compressor and accessories, together with the necessary electrically driven pumps for delivering the distilled water into a hot-well tank, or alternatively to the storage tank situated on the roof of the building. The condenser, which is shown in Fig. 6, was built by W. H. Allen, Sons and Co., Limited, and contains 6030 brass tubes ¾in. in diameter and 15ft. long.

In order to ensure that the circulating water is free from suspended matter it is passed through disc type self-cleaning water screens, as shown in Fig. 5. Two of these screens, made by F. W. Brackett and Co., Limited, are in use, and the whole of the circulating water has to pass through them before entering the suction duct leading to the pumps. The principle upon which these screens work has already been described in these columns. Each screen is capable of dealing with two and a-half million gallons of water per hour, and is complete with the necessary pumps for the water jets.

An interesting feature of the station is the arrangement of the oil break switches and other apparatus necessary for controlling the electrical output. The whole of the high-tension switchgear is contained in a separate building a short distance from the turbine room, and the switches are operated electrically from the control room, which is situated in an annexe of the turbine room. A view of the control room is given in Fig. 2. In the switch house the extra high-tension switches are placed in separate cubicles, each provided with a pair of iron doors in the external walls of the building, and it is only through these doors that access to the cubicles can be obtained. A subway between the turbine house and switch house serves to carry the whole of the cables and the control wiring, and is of sufficient size to permit of repairs and inspection to be carried out in comfort.

FIG. 5—SCREEN FOR CIRCULATING WATER

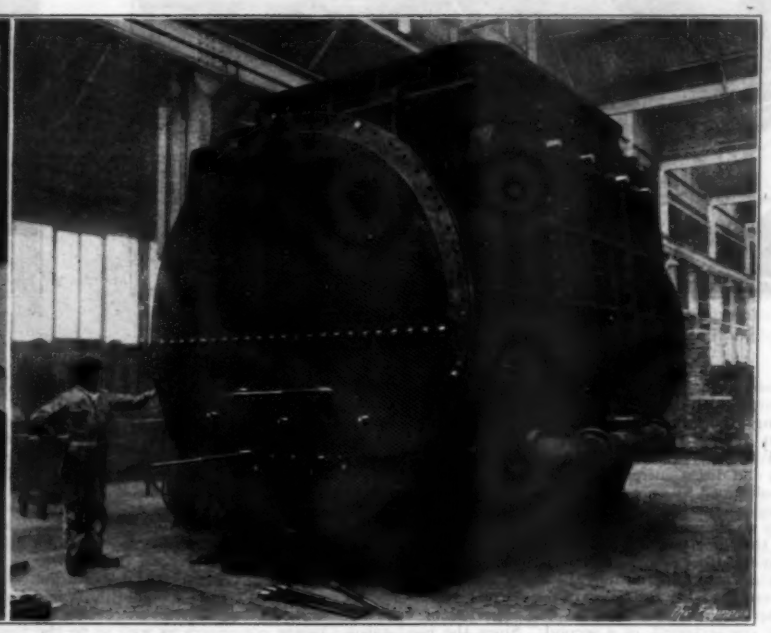


FIG. 6—CONDENSER FOR 10,000-K.W. TURBO-ALTERNATOR

Recent Researches on Lubrication.

THE ninth Thomas Hawksley lecture, entitled "Some Recent Researches on Lubrication," was delivered by Dr. T. E. Stanton before the members of the North-Western Section of the Institution of Mechanical Engineers on Thursday, December 7th, in Manchester, Mr. Charles Day being in the chair. There was a good attendance of members. After the lecture, the Chairman stated that the author would be pleased to reply to any questions which the members desired to ask. The Chairman said he had noticed, on looking at the diagrams, how the bearing moved out of centre under different conditions of load, speed, &c., and he asked, what would happen if the bearing were restrained from this excentric movement, as in the case of the strong crank shaft with six bearings in line, all of which were more or less rigid. With regard to lubricating oils, Mr. Day said that one quality he had always looked for was constant viscosity. Castor oil, though once very popular was, he said, not used so much now, partly owing to the expense, but chiefly owing to the fact that when cold, castor oil was very thick, whereas, when hot, it was almost as fluid as water.

Answering a number of practical questions, Dr. Stanton stated that he really did not know what would happen in the case of a rigid bearing, but imagined that wear would take place until the correct radius difference was obtained for suitable working conditions, but it was not his opinion that the shaft would be distorted. In reply to Mr. Millington and others who had mentioned the question of the composition of the bearing and the journal, Dr. Stanton stated that in the experiments undertaken the journal itself was composed of tool steel hardened and ground, whilst the bearing was phosphor bronze. These metals had always been found to work satisfactorily. He mentioned a relieving device always used in the experiments, which enabled the load to be put on or off gradually, so that the machine was never stopped or started under a heavy load. It no doubt saved the bearings a good deal of wear. When starting and stopping a machine, Dr. Stanton admitted, the question of metals was important, but once continuous rotation had been set up it was purely a matter of lubrication. Graphite, although not used in these bearings, because of the difficulties which might be encountered, had been used quite successfully in worm gears, in some cases with a slight improvement in efficiency. Experiments were being undertaken by different people with regard to the production of oilless bearings, which was quite an important question, as Britain, having no oil supply in her own country, would be placed in an awkward situation by the stoppage of the oil supply from abroad. With regard to oil grooves, they should not be used, neither were they at all necessary, when the rotation was continuous. The oil was fed in at the bottom of the journal, and the bearing picked it up and carried it to the pressure region. In the case of a rocking shaft it would be necessary to have oil grooves in order to get the oil in. Dr. Stanton was very interested in Mr. Hull's remarks with regard to the use of mutton fat and white lead. No other lubricant than vegetable or mineral oil had been used, however, in the experiments undertaken by him.

With regard to Mr. Bissett's point about the difference effected by a slight endwise movement in a journal, in his own experiments he had noticed the effect of any slight distortion. He had experienced considerable distortion in a test where the load, not being quite symmetrical, did not come in the centre of the journal. It was quite possible that if there were any distortion one position would be more favourable to successful running than another. With regard to over-oiling, the quantity of oil made very little difference. Successful results had been obtained with forced lubrication, but quite a small amount of oil had given equally successful results. However much oil was used there always remained a certain amount of frictional resistance. The importance of the metal of the bearing also entered into account here. Successful running was largely a matter of temperature, and if the facilities for the escape of heat could be increased, either by lubrication or difference in the composition of the bearing or the journal, it would be possible to run at a higher temperature.

NEW ZEALAND RAILWAYS.

FOR the year ended March 31st last the net earnings showed a decrease of £866,066, compared with the result of the previous year. Although the gross earnings declined by £264,940, the working expenses advanced £601,126. The number of employees increased from 14,252 to 15,662. As no account is given of the interest due on loan capital, the railway deficiency cannot be arrived at.

Result of Working.

	Year ended March 31st, 1922.	1921.
Total miles open	3,030	3,018
Average miles open	3,026	3,018
Capital cost of lines open	£39,309,097	£37,235,254
Capital cost per mile	£12,973	£12,337
Gross earnings	£6,643,591	£6,908,531
Working expenses	£6,237,727	£5,636,601
Net earnings	£405,864	£1,271,930
Net earnings to capital invested, per cent.	1.07	3.42
Working expenses to earnings, per cent.	93.89	81.59
Passengers, ordinary	14,262,440	15,315,640
Season tickets	472,865	464,691
Goods tonnage	5,931,112	6,085,360
Live-stock tonnage	390,239	401,919
Train miles	8,717,265	9,303,392

THE Canton Cement Works have been working day and night through most of the past year, turning out about 13,500 casks per month, and are said to have made a profit of 300,000 dols. Mex. The establishment, however, is an official one and remits to the provincial authorities most of its net earnings.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE HISTORY OF STEEL MAKING.

SIR,—In the discussion on Mr. Rhys Jenkins' delightful and suggestive paper on "The Early History of Steel Making in England," read on November 27th before the Newcomen Society, reference was made to the date at which the *rôle* of carbon in steel was recognised as differentiating it from wrought iron. In this connection I venture to suggest that somewhat less than justice has been done to the metallurgists of the seventeeth and eighteenth centuries, and more especially to Réaumur, whose "Art of Converting Wrought Iron into Steel and of Softening Cast Iron" (Paris, 1722), contains abundant internal evidence that he rightly understood the part played by carbon in both operations. It is true that he reiterates *ad nauseam* that the difference between wrought iron and steel consists of the presence in the latter of more sulphur and salts than occur in the wrought iron, but he states most distinctly that these sulphurs and salts are identical in kind with those present in pig iron, which differs from steel in containing more of them and of earthy substances, while wrought iron contains much less than steel. He foreshadows a process of making steel from molten iron by withdrawing only as much of the "sulphurous" body as would reduce its amount to that present in steel, whereas, as he explains, in making wrought iron by puddling, it is all, or nearly all, burned off, and he explains that the oft-quoted passage in Biringuccio affords evidence that this view is correct, as the iron rod "drinks up" from the molten iron those sulphurs which the molten iron contains, and becomes steel through having more, while the molten iron thereafter contains less.

These and similar passages require to be read in the light of what, in the contemporary nomenclature, sulphur and salt really meant. Their dualism was in strong dispute. Even Bacon repudiated the necessity of postulating the existence of both in the constitution of matter. They may be regarded as often synonymous, and therefore redundant, although at times they conveyed distinct ideas. The one thing positive in alchemical and iatro-chemical literature, which subsisted up to the time of Réaumur is that unless specially qualified with that object, sulphur did not mean brimstone, nor sulphurous bodies bodies containing the element sulphur, as we mean it. There are thus two lines of inquiry: What did Réaumur mean by the term "sulphur," and what did he certainly not mean?—a distinction, like that drawn by the Hatter in "Alice in Wonderland," not always clear in metaphisico-transcendentalist modes of expression of the nature employed by the older writers, and in respect of which modern writers are by no means blameless.

Not to multiply instances, and in order to restrict the issues, it will, to begin with, suffice to show what Réaumur did not mean, with the object of ascertaining by such elimination what conception he had actually formed in regard to the influence of cements in converting wrought iron into steel. With this object, it will be convenient to quote from an author who wrote approximately fifty years before (1671) and from one who wrote approximately forty years later (1764), thus bridging a period of roughly a century in the middle of which Réaumur's first edition was published (1722).

The matter, says Webster—"Metallographia or an History of Metals," London, 1671—out of which the metals were generated were sulphur and mercury. "Basilius, Valentinus, Paracelsus and the later Chymists have added Salt as a third; which notwithstanding though they seem to make three in number and properties, yet they intended but one substance or essence; and the most of them joyned Salt with the Sulphur so that in effect they held but two. And this Sulphur and Mercury they did not mean of those that are vulgar, as the most of their adversaries have too grosly mistaken, and therefore it will be necessary in the first place to clear what they intended by Sulphur and Mercury." (Page 72.)

Into this dissertation, attractive though it be, it is unnecessary to enter. It will be enough to quote Webster once again—*ibid.*, page 74. "Our Sulphur," he declares, "is not vulgar sulphur."

Cromwell Mortimer, in 1764, published a second edition of his translation of Cramer's lectures on assaying—"Elements of the Art of Assaying Metals." He says, pages 7–8: "Whatever is inflammable is called among the Chemists by the general name of *Sulphur*. You will find it in the Mineral Kingdom always mixed with acid, otherwise the pure inflammable mineral seems not to differ from the vegetable and animal nor does it seem that there are two kinds of it in nature." On page 26 he further speaks of adding to the "calxs" of metals "a Sulphureous Body *without any vitriolick Acid* and so fixt of its Nature as not to be dissolvable by any but a great Fire," and proceeds to give a perfectly correct account of the reduction of metals from their oxides by the "oily exhalations of the burning Coals." Later, he gives a list of the inflammable minerals that *differ*—see above—"from Sulphur (Mineral Sulphur: Brimstone) strictly so-called." They include naphtha, petroleum stones, bitumen, asphaltum, jet and stone coal (or quarry or sea coal).

These quotations show that Réaumur, using the language of his period, did not mean sulphur compounds and salts, in the sense of compounds of the modern element "sulphur" when he spoke of "sulphurs and salts." A significant passage in his book, page 207, says that the heated and dilated metal becomes penetrated by particles of fire bringing with them sulphurous particles. "The fire itself is but sulphurous particles, but not all the particles of this nature which the heat bears with it are inflamed to the degree necessary for combustion; the fire of our ordinary grates affords proof of this. The soot which is therein deposited has been mingled with the flame, of which it was a portion, yet, nevertheless has remained a highly combustible material."

Réaumur's experiments were business-like and scientific. He subjected pieces of wrought iron of identical size, quality and weight to heat in contact with various cementing substances, and he attributed this conversion into steel "solely to the differences in these materials"—page 15. Experiments without carbonaceous materials led him to select "charbon" as a basis—page 26—either alone or with salt, which seemed to accelerate its action. The results were not permanent, "as they were when carbon alone was used"—page 29. The influence of sulphur was to inhibit the action of the carbon on iron and to prevent it becoming steely—page 30. Yet the blisters which formed on the bars are ascribed to the sulphurous matters which penetrated them—page 185. He perceived that what was added was not iron—page 204. Finally, he recognises that only a carbon-lined crucible can impart to the iron that which is needed to convert it into steel—page 247—and, moreover, he proclaims the identity of what is taken into the wrought iron with what is present in molten cast iron, and that its removal will reconvert either cast iron or steel into soft and "purer" iron.

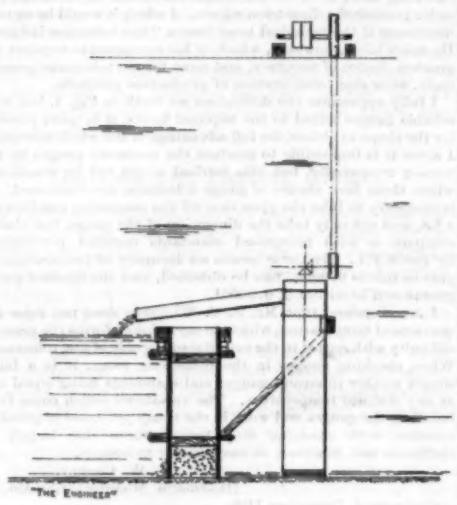
I think the passages quoted serve to show that Réaumur's sulphurous or oily particles were carbon particles, and that there was no confusion in his mind as to the *rôle* they played. Nor is there really any confusion as to language, when once the identity of inflammable particles and the "sulphurs" of Réaumur's day is fully realised.

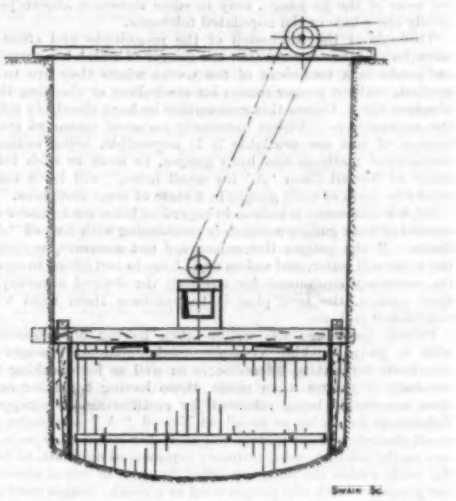
London, S.W. 11, December 11th. L. P. SIDNEY.

REPAIR OF AN OLD CANAL LOCK.

SIR,—Your readers may be interested in a brief account of a repair job which I have recently completed on the North Walsham and Dilham Canal. This canal is an East Norfolk waterway, 9 miles in length, which provides the triple service of power for corn mills, drainage for an agricultural district, and water communication by means of the Broadland rivers with ocean-going craft in Yarmouth and Lowestoft harbours. The Ebridge Lock on this waterway is about 110 years old, and is of brick, 20ft. 6in. deep to floor, 14ft. 2in. width at bottom, with 7ft. depth of water. The overflow from the reach above enters the canal a few yards below the lower doors, and it was therefore essential to dam the water on the brick apron below these.

The surface of this apron is somewhat irregular, and in order to obtain its contour, ordinates were taken at water level and transferred to a wooden template, which was then sunk and corrected where necessary. A bottomless crib was then made, about 18in. less in length than the distance between the lock walls. The pressure side of this crib is of 2in. grooved and tongued matching, the sides are spaced 2ft. 2in. apart—sufficient for a man to work in—and have their bottom edges shaped to the template above mentioned. Suitable distance pieces are provided and top and bottom walings through bolted at the distance pieces. The crib was loaded with about ¾ ton of fire-bars and lowered into position. Two timbers were then fixed across the lock walls in holes previously cut in the latter, and the crib was wedged down on to the lock floor from the timbers. Raking struts to the pump support took the inward thrust at the bottom. At the ends of the crib two pairs of long folding wedges were fitted to the lock walls and driven home. The crib was then puddled to a depth of 2ft. and rammed. The spaces at the ends





REPAIRING A CANAL LOCK

enclosed by the above-mentioned wedges, the lock walls and the crib were similarly treated.

Pumping was begun within twenty-four working hours of the passage of the last barge, when it was found that the dam was practically tight, and only needed a few pailsfull of fine ashes on the water side to make it absolutely so.

Incidentally, attention may be drawn to the primitive pump used. It consists merely of a wooden trunk, 2ft. square by 9½ft. high, provided at the bottom with a diaphragm above the suction grid. A bevel counterdrive at the top communicates motion to the vertical shaft, on the bottom of which is hung the centrifugal impeller working over the suction hole in the diaphragm. While inefficient, it has the advantages of requiring no fixing beyond a lashing at top, no suction pipe and no priming. It delivers 600 gallons per minute, is driven by a 6 horse-power petrol engine and could probably be made to-day for a £10 note.

ARTHUR WALKER,
Engineer and Secretary to the North Walsham Canal Company, Limited.

December 11th.

ELECTRIC LOCOMOTIVES.

SIR,—My attention has been drawn to the excellent article which appeared on the above subject in your issue of November 24th last, in which you drew attention to the lack of interest indicated by chief mechanical engineers of British railways to the very charming and highly significant paper read by Sir Vincent Raven before the Institution of Mechanical Engineers. You refer to the fact that electrical engineers had the matter all in their own hands, and that it was to be regretted that none of the chief mechanical engineers spoke. Well, surely, if they have got the wind up, they can please themselves.

As you rightly say, the railway locomotive is a vehicle, and the mechanical science entailed in the design and construction of such vehicles is not limited to those few gentlemen comprising the chief mechanical engineers. In fact, some of the most advanced mechanical design and construction is to-day to be found in the actual construction of electric locomotives, not only in this country, but nearly all over the world. Judging by the open-minded manner in which Sir Vincent Raven dealt with the subject of both "steam" and "electric" traction, it goes at least to indicate that as a locomotive traction engineer, he does not mind which type of vehicle he uses, provided that one type is "commercially" better than the other.

I have in my time attended many meetings, both in this country and on the Continent, and I must say that the chief mechanical engineers of this country do not have that open-mindedness which certainly does show up in connection with continental locomotive engineers.

The whole facts of the case, in my opinion, are that the British railway directors have left too much to the chief mechanical engineers; consequently, these gentlemen have all developed babies of their own in the form of Early Victorian steam vehicles, and the actual experience available to-day is limited only to the hundred years' development of the so-called steam locomotive.

What is the consequence? Electrical engineers have had to develop all their own ideas and try them out, or have been driven to copy American or German practice, with few exceptions. I also find that foreign railways do not waste their shareholders' money in the unprofitable practice of building railway locomotives. They generally put out their requirements to tender, and consequently secure the advanced talent and competition from properly qualified railway vehicle builders, who are not bound by some particular man's limited views, but have the full advantage of modern workshop methods and machinery to be found in outside locomotive building workshops.

Whilst the chief mechanical engineers hide themselves like Brer Rabbits, electrical engineers are getting ahead, and even they, in turn, get up a fight between themselves in the form of the famous "Battle of the Systems." One gang wants alternating and the other gang continuous current, and so this country lacks cheap transport and suffers from lack of cheap manufacturing facilities, and always will do unless we develop sufficient courage to kick out the railway inefficiency and provide the means by which our national fuel, coal, can be utilised in proper form and immediately put to work that very efficient vehicle, namely, the internal combustion railway locomotive; and in connection with this, I would mention that to-day we have the necessary talent, the practice and the means, thanks to English industry and business acumen.

London, December 9th. WILLIAM P. DURTNALL.

ERRORS OF GAUGING.

SIR,—As I have been a member of the British Engineering Standards Screw Gauge Committee for many years, I read Mr. Wickman's letter in yours of 8th inst. with interest. I agree with him that it would be difficult to produce go and not-go gauges of sufficient accuracy to enable ½in. holes to be produced to a tolerance of .0005in., if the firm who makes the gauges is only provided with the usual equipment of micrometers and slip gauges.

When I was working with the late O. P. Clements, of the Birmingham Small Arms Company, who was the first man to manufacture bicycle parts in quantity to very narrow tolerances, and who then obtained the very perfect interchangeability for which B.S.A. bicycle parts are so celebrated, we came across this difficulty, as we had to measure accurately the change of form and of dimension which takes place after hardening of such steel parts. I then suggested and myself made up two examples of end-measuring apparatus, by which cylindrical gauges or end lengths could be rapidly checked and compared to two parts in a million. We found that when we attempted to use the very beautiful and expensive comparators made by the Société Genevoise and by the then existing firm of Newalls, it was a very tedious and almost impossible process to measure to the above degree of accuracy.

It is obvious that with such apparatus the piece to be measured must remain long enough in the comparator to settle down to the identical temperature of the comparator itself. If we add to this the temperature error introduced by the approach of the hand of the operator himself to the part being measured, which being small has its temperature raised thereby to a greater degree than that of the heavy parts of the comparator itself, errors are introduced greater than the two parts in a million.

To get over this difficulty, I designed a comparator consisting of two mild steel tubes about 2in. diameter, carried on specially designed cast iron heads, which could be slid along the tubes, which had been previously ground and lapped to true cylinders, so that these heads could be clamped at any desired length. The heads and the thickness of the tube were so calculated there was no considerable mass of material at any part to absorb temperature from the body of the operator at a rate slower than the specimen itself would absorb heat. Our means of measurement was obtained by mounting in one of the heads a carefully prepared measuring screw, having 100 threads to the inch, carrying a hand wheel graduated to 500 parts, so that 1 deg. was equal to two-millionths of an inch. The graduated wheels were specially made for us by the Société Genevoise; in other cases, by Messrs. Cook, of York, and by Warner and Swasey, of Cleveland, U.S.A. The screws were made as perfect as possible by using an averaging machine to take out periodic error,

and by final grinding on a well-known process invented by Rowland in America for the special machines made for him by Brashear for ruling gratings.

At that time we had not the advantage of being able to use the very beautiful and accurate slip gauges made by Johannsson, but now that these are available, with my form of comparator there should be no difficulty in rapidly making the transfer comparisons from the newly made gauges to the Johannsson slip gauges and to record such differences as exist to the above limits of accuracy.

I should add that the abutment head of my comparator contained a sliding cylinder which took up the end pressure, transferred it to a spring, and the point at which end electrical contact was made was indicated by a delicate galvanometer. With this comparator I was able not only to take lengths accurately, but was able to do it so rapidly that I was able to record and make diagrams of the fluctuations in length which always occur after steel is newly hardened, and it shows alternations of increase and contraction continuing for a short period after hardening, and which gradually decrease until stability is reached. These fluctuations have been quite recently described by Sir Robert Hadfield. In order to observe these early fluctuations, the process must be rapid enough that several check measurements can be made per minute.

I suggest therefore to Mr. Wickman that any firm who wish to equip themselves with accurate means of transfer measurement so as to use Johannsson slip gauges, must devise and use a transfer measurement means somewhat similar to mine.

December 12th. R. E. Crompton.

Sir,—Mr. Wickman's letter under the above heading, which appeared in your last week's issue, contains much justifiable criticism of current methods of applying limit gauges. He is to be commended in particular for indirectly denouncing the fixing of tolerances by the drawing-office without reference to actual practice in the shops, as well as the fixing of unnecessarily small tolerances. He is also undoubtedly right in stating that firms ignorantly starting out with too fine tolerances will gradually drift back to old methods, with consequent discredit to the limit gauge system—invaluable if intelligently and properly applied.

In the main, however, his letter is concerned with stated unavoidable errors that enter into gauge manufacture, and he endeavours to show that these, together with the allowance for wear of the go gauge, may in some instances absorb practically the whole of the stipulated tolerance.

Throughout the discussion of the magnitude and effect of these factors, he assumes that the gauges of which he is writing are made in a tool-room of the works where they are to be applied, without proper means for controlling or checking their absolute size. Unless this assumption be kept clearly in mind, the statement:—"Unless extremely accurate means of transference of size are available it is impossible, using ordinary commercial methods and limit gauges, to work to such tolerances as Newall Class 'A' for small holes," will leave many would-be users of limit gauges in a state of utter confusion.

Such a statement is untrue in regard to holes made under the control of limit gauges accurately conforming with Newall "A" limits. If the gauges themselves are not accurate, naturally the work will suffer, and unless users have or can afford to secure the necessary equipment for ensuring the desired accuracy in their gauges, the best plan is to purchase them from well-established makers.

Fifteen years ago the writer—then having no connection with a gauge making concern—used Johansson gauges as standards for setting micrometers as well as for checking the accuracy of gauges when made, those having a greater error than acceptable being returned for rectification or scrapped. Tolerances for holes as small as Newall "A" tolerances for small diameters were seldom required, but when they were, it was easily possible, using ordinary commercial methods, to keep the work within the limits specified, in spite of initial errors in the gauges. With slip gauges used as a check, gauges need not contain such great errors as Mr. Wickman would lead your readers to believe.

In addition to the Johansson standard gauges, and imitation Johansson standard gauges marketed by Alfred Herbert, Limited, there are several excellent measuring machines available for users able to afford them. Many such machines are now in use throughout the country, and, although no doubt there exist a few firms that purchased machines of this type during the war and now use them inefficiently, there are many others that obtain excellent results from them.

When used intelligently, neither the measuring machine by the Société Genevoise, nor that made by the Newall Engineering Company, suffer from the defects mentioned by your correspondent.

Reverting to Mr. Wickman's contention, we read in reference to the making of a small plug gauge having Newall Class "A" tolerance of .0005in.:—"We have now absorbed the entire limit of .0005in. in errors of standardisation, tolerance of manufacture on the gauge and wear limit, and no factory which uses micrometers and slip gauges as a means of standardisation can do any better."

Also later:—"If standards of extreme accuracy were not available there might be some excuse for the present state of affairs; but they are available. Slip gauges can be purchased which have a guaranteed error well inside plus and minus .00001in. It is the connecting link—that is, the means of transferring these sizes on to the gauges being made—which at present is missing."

It would be interesting to know in what respect the slip gauges which offer no excuse for this state of affairs differ from those with which, according to the earlier quotation, the desired degree of accuracy is unattainable; also whether the missing connecting link contemplated is Mr. Wickman's own measuring machine.

One result of this discussion, which perhaps at this stage of the B.E.S.A. deliberations on limits may be of interest and value, is that it calls attention to the fact that, although there may not be agreement as to the magnitude of errors involved in gauge making, these must necessarily be inside the limits. In other words, to allow for wear and errors of standardisation and workmanship, the specified tolerances must be robbed. It necessarily follows that, because in the case of holes the wear allowances must be on the go gauge, all holes controlled with so-called unilateral gauges, *i.e.*, with the low limit nominally of nominal size, must necessarily be over-size.

When in addition to the above error and wear factors we take into account the amount by which the hole must exceed the size of the gauge, in order that the latter should enter it freely, it will be clearly understood that for many holes the actual hole size will be considerably above the normal. Is this desirable, and does this result comply practicably and economically with the necessarily frequently related sizes of well standardised products, such as reamers and ball and roller bearings? Would it not be more practicable to adopt by analogy the device of the late Mr. Willett, tardily accepted after his death, by putting the clock forward to secure increased daylight in summer while leaving time-tables unaltered?

The proposed unilateral limits for holes, if rigidly adhered to, will necessitate the alteration of many standardised products, to say nothing of needless scrapping of gauges, a result that could so simply be avoided by including as standards certain holes with bilateral limits. Just as the simplest plan was to alter the clock, so in this case the placing of the low limit for certain holes below the nominal will surely be simpler and cheaper than forcing the alteration of products already standardised. This practice, moreover, is justified by its adoption by the majority of those firms that for years past have been sufficiently enlightened to use limit gauges.

London, December 13th. Hedley J. Thomson.

Sir,—Your correspondent, Mr. Alex. C. Wickman, in his letter which appears in the current issue of The Engineer, does not appear to have a very charitable opinion of the gauging methods adopted by the majority of engineering works in this country. I must say I find myself in disagreement with his general view of the subject, and feel that he has not met some of the better systems of gauging in vogue in many of our engineering workshops.

His letter gives me the impression that he is confusing the issue between the actual problem which faces those who "profess to manufacture products which are interchangeable and to definite limits," and the method of gauging adopted by, and probably quite suitable to, those who are manufacturing to class "Z" limits. It is known that some manufacturers have limit gauges in use the tolerance of which is determined by the price paid for them, but if these conditions suit the particular mechanism produced, why go to greater expense if finer tolerances are unnecessary.

As regards the fixing of the tolerances, in the first place, your correspondent apparently advocates a "mutual settlement" between the drawing-office and the works. I fear this might lead to a state of affairs worse than that which he describes. It must be remembered that the human objective of the manufacturing head is to obtain broad tolerances on all details, in order to minimise dimension rejects. I admit it would be equally disastrous if the technical head were a "fine tolerance faddist." He must know, however, which of his components requires the greatest degree of accuracy, and must fix the tolerances accordingly, after due consideration of production methods.

I fully appreciate the difficulties set forth in Fig. 1, but with reliable gauges suited to the required limits, it is quite possible for the shops to obtain the full advantage of the whole tolerance. I agree it is impossible to produce the necessary gauges by the vernier micrometer, but this method would not be considered where those finer classes of gauge tolerances are concerned. It is necessary to take the glass case off the measuring machine for a bit, and not only take the dimension of the gauge, but also to compare it with recognised standards certified periodically by the N.P.L. By these means an accuracy of transference to plus or minus 0.00002 can be obtained, and the finished gauge guaranteed to within ± 0.00001.

I am surprised that Mr. A. C. Wickman does not raise the question of temperature, which, in my opinion, forms the greatest difficulty with regard to the manufacturing side of fine tolerances. When checking gauges in the measuring room, it is a fairly simple matter to ensure gauges and standards being equal and at any definite temperature. The variations which come from handling the gauges and work in the many processes of grinding together with changing shop temperatures—due largely to traffic—is not, however, an easy matter to control.

T. W. Cooper
(Hoffmann Manufacturing Co.).

Chelmsford, December 11th.

Sir,—I have read Mr. Wickman's letter with great interest. His point as to the importance of studying tolerances on gauges, as distinguished from tolerances on work, is one we have understood here for something like thirty years, but it is not a point at all commonly understood, and when, in the early history of the Engineering Standards Committee on Screw Threads and Limit Gauges, I endeavoured to point out that it was vital to any proper consideration of tolerances on the work, my suggestion was regarded as finicking and frivolous. It was the war which compelled people to recognise for the first time that tolerance on gauges was a very vital thing.

I have always advocated that since the provision of cheap limit gauges is perhaps the most vital thing in getting systematic limit gauging more generally adopted, the Engineering Standards Committee should standardise the tolerances on the gauges; otherwise the gauges will remain in the condition in which rolled joists were before they were standardised, every user having his own ideas, so that the utmost mass production and economy in gauge making are unattainable.

Leicester, December 12th. Wm. Taylor.

THE HUMAN SIDE.

Sir,—If you will permit me to say so, I do not think the technical Press pays sufficient attention to the human side of engineering. Your own and other papers give a great deal of space to technology and science and deal with industrial problems, but only very rarely do you print articles about the human experiences of engineers—particularly young engineers—in the pursuit of their calling.

Now, I think we may say that in 999 men out of 1000 the human side is uppermost, however keen they may be as engineers. The first thing they have to do is to make enough to keep soul and body together, and perhaps provide also for a wife and children. After all, engineering is a means of livelihood.

What I want to do is to ask you to allow some of us to use your correspondence columns to tell others about our difficulties and troubles, to growse a little, and to discuss how to get over obstacles. I am sure many letters would be complaints and grumbles against fortune and employers, but they would have their human interest none the less. I believe even such letters might be of help to others.

Then there are a lot of young engineers abroad who could give very useful information about the life of engineers in the Colonies and Dominions, in India and the back parts of the Empire. There are warnings and advice that are wanted by young men who think of pursuing fortune abroad.

Other young men have given up engineering in despair. One would like to hear from them, too.

In fact, Sir, there are a great many human subjects that would be all the better for ventilation and through the discussion of which some of the difficulties of young engineers might be removed. May I ask therefore if you would be good enough to consider my proposal?

December 12th. Timon.

[We publish the above letter, with the writer's permission, because that seems to us the best way of presenting his suggestion. We are fully in sympathy with "Timon," and we can assure him and other engineers that these correspondence columns are quite open to them, and that we shall be very glad to hear from them. We must, however, be allowed to exercise our discretion as to the publication of letters and parts of letters. Many grumbles come our way, but for various reasons—sometimes to avoid libel actions!—we cannot print them. With that condition we shall be only too glad to hear more of the Human Side of Engineering.—Ed. The E.]

BREAKDOWN CRANES.

Sir,—In your current issue you describe a 40-ton breakdown crane for Jamaica, and state that you believe this to be the highest capacity breakdown crane that has so far been constructed in this country.

This is not the case, as we have recently constructed and delivered to the Egyptian State Railways a crane of 40 tons capacity, with a working radius of 23ft., which is more than 50 per cent. greater outreach and consequently of greater capacity, than the one you describe. The crane was made for 4ft. 8½in. gauge, carried on ten wheels, the three centre pairs of wheels being arranged on a fixed wheel base and the two outer pairs each carried in pony trucks. It is also provided with our improved system of hinged outrigger supports, instead of the usual telescopic draw-out beams, and was tested at our works before delivery with a test load of 50 tons at 23ft. radius.

We also delivered about the same time four cranes for the South African Railways, also of larger capacity than the one you refer to. These cranes were made suitable for 3ft. 6in. gauge, with a capacity of 36 tons at 21ft. radius, and they were tested at our works with a load of 45 tons at this radius. The general features were similar to those briefly described for the 40-ton crane.

We shall be glad if you will publish these facts in your next issue, and so correct the erroneous impression created that breakdown cranes of higher capacity have not previously been made in this country.

For and on behalf of
Craven Brothers (Manchester), Ltd.,
W. H. S. Craven, Director.

Reddish, Stockport, December 11th.

A STEAM ENGINE PROBLEM.

Sir,—I am almost certain that I have seen in The Engineer and in other places that if the stuff in a steam cylinder at the point of compression is wet and contains as much as one-third by weight of water, it is impossible to compress it. This sounds reasonable and is borne out by the square corner of indicator diagrams taken when steam is very wet, but I am anxious to get to know who is the authority for any tests that may have been made to verify that it is so. I must apologise for troubling you, but if you or some of your readers can tell me where I can obtain some definite information on this point, I shall be greatly obliged.

December 9th. K. P.

THE "ELECTRICALS" EXAMINATIONS.

Sir,—In reference to the October, 1922, results of the A.M.I.E.E. examination, I beg to draw your attention to a slight error that occurred in the published list of successful candidates The name "W. F. Cresswell" should have been "W. F. Gresswell," that is, "G" instead of "C." The error is very small, but misleading, as no doubt you will agree.

December 6th. W. F. Gresswell.

EDUCATIONAL INTELLIGENCE.

Jig and Tool Design.—A class for instruction in jig and tool design has been started at the Polytechnic, 309, Regent-street, and is conducted by Mr. C. A. Clarke. It is held on Mondays from 7.30 to 9.30, and the next term will begin on January 8th. The fee for students residing in the Administrative County of London or the County of Middlesex is 10s. for the term ending April, 1923. For students residing in counties other than London and Middlesex, but working inside London the fee is £1, or for such students working outside the Administrative County of London the fee is £2.

In addressing a meeting at Bristol on December 1st, Mr. Norman Wyld, director of the Society of Technical Engineers, suggested that a most useful purpose would be served if the Society, representing, as it did, so wide a range of the administrative and technical workers in the engineering industries, were to organise the collection of data as to the exact nature of the problems that each of them had to meet in his daily work, so that an adequate picture might be built up of what "the capitalist system" really was. The manual workers naturally imagined that production was all that was needed, but of the much greater difficulty, namely, the business of selling, they took little or no account, nor did they have any picture of the process of finance. The Society should aim at showing the nature of the problems involved, so that there might be less eagerness to destroy offhand the existing system, by which they did manage to live somehow for some other, in the nature of the case, an untried one, in the too-eager search for which they might easily arrive at starvation.

A Seven-Day Journal.

The Late Colonel Denny.

THE commercial side of the shipbuilding industry has lost an outstanding figure by the death of Colonel John M'Ausland Denny, chairman of William Denny and Brothers, Limited, of Dumbarton. Colonel Denny was in his sixty-fifth year, and died last Saturday at a nursing home in Glasgow. He was the fourth son of the late Dr. Peter Denny, a founder of the firm, and himself one of the four sons of Mr. William Denny, who started shipbuilding at Dumbarton in the early years of last century. The late Colonel Denny, after an education in his native town and in Switzerland, returned to Dumbarton in 1875 at the age of seventeen and entered the firm's counting house as an apprentice, and subsequently took over the control of that department. Six years later he was admitted a partner in the firm, and began to take an active part in its business. While his brother, Sir Archibald Denny, concentrated his attention on the technical side of shipbuilding, he himself remained to the end chiefly concerned with the commercial side to which he had originally been allocated. Outside his business he had many activities. He was a keen Volunteer, and for a period of ten years was a Member of Parliament. In addition, he was a director of many important companies, including the Caledonian Railway, the Irrawaddy Company, the Union Steamship Company, and Tankers, Limited, and took a prominent part in the work of the Shipbuilding Employers' Federation.

The New Battleships.

As anticipated, the Government has decided to proceed immediately with the laying down of the two new battleships permitted to this country under the Washington agreement. On Tuesday the Admiralty intimated that the hull of one of the vessels is to be constructed by Armstrong, Whitworth and Co., Limited, and the engines and boilers by the Wallsend Slipway and Engineering Company, Limited. The hull and machinery of the second vessel are to be built by Cammell Laird and Co., Limited. Orders for the armour plate have been distributed between Sheffield, Manchester and Glasgow. The guns will be made at Newcastle, Sheffield, Barrow, Manchester, Glasgow, Darlington and Woolwich, and the gun mountings at Barrow and Newcastle. It is estimated that the vessels will take about three years to complete, and that some 500 firms will be engaged in the supply of material for them. During the first three months from 4000 to 5000 men will find employment on work arising out of the contracts, and by the end of a year the number will have risen to 29,000. Subsequently it will for a time be as great as 40,000, and on the average throughout the whole period will be about 21,000. The total wages bill will amount to some £10,000,000. Apart from these two battleships the Admiralty does not contemplate any more constructional work in the near future. The reference in the official announcement to the "engines and boilers" of the first ship and to the "machinery" of the second may lead some to wonder whether the second is to be equipped with propelling machinery of other than the usual type. We are informed by the Admiralty that there is no significance in the phraseology.

The Government and Armament Firms.

THE placing of the contracts involved by the decision to construct the two new battleships will bring relief not only to the labour situation in the districts undertaking the work, but will also release the heavy armament firms from a situation of unprofitable uncertainty. After the war certain firms were requested not to dismantle plant suitable for the manufacture of heavy armaments without first obtaining Admiralty sanction. Some of them—particularly those in the Sheffield area—have for some time desired to be released from this obligation in order that they might make arrangements for replacing the plant in question with other plant suitable for the manufacture of articles and implements of a lighter nature. From a reply recently given in Parliament by the Financial Secretary of the Admiralty, it is to be gathered that the definite allocation of the contracts for the armament of the two new vessels will release the manufacturers from their obligation except in so far as the plant required for the execution of the contracts awarded to them is concerned. Consideration of this point, as well as of the relief of unemployment no doubt weighed with the Admiralty in coming to its decision to distribute the orders for the armour plate between three centres and the orders for the guns over seven.

The Therm Inquiry.

As an outcome of the agitation expressed by a considerable number of the public against the system now in force for charging for gas consumption on a thermal basis, a Departmental Committee was recently appointed by the Board of Trade to make inquiries and report on the matter. This Committee consists of Sir Clarendon Hyde, vice-chairman of S. Pearson and Son, Limited; Mr. Arthur Balfour, vice-president of the Association of Chambers of Commerce; Sir James Martin, senior partner of Martin, Farlow and Co.; Mr. A. A. Pugh, secretary of the Iron and Steel Trades Federation; and Mr. W. J. U. Woolcock, general manager of the Association of British Chemical Manufacturers. The first meeting was held on Tuesday in the hall of the Institution of Civil Engineers, and evidence was given by Mr. H. C. Honey, Director of Gas Administration at the Board of Trade, and by Professor C. V. Boys, one of the gas referees. Professor Boys said that when the therm system was introduced authority was given concurrently to charge an increased price for the same gas and that the larger gas bills complained of by the public had nothing to do with the therm system. Mr. Honey gave figures derived from the working of the Gas Light and Coke Company for the first six months of this year, which, he said, answered the allegations that a general increase in the consumers' accounts followed the introduction of the therm system. As compared with the corresponding period of 1921 the average consumption by the ordinary consumer increased by 7.7 per cent., while the company's receipts from him rose only by 2.42 per cent. The average consumption by pre-payment consumers fell by 2.42 per cent., while the receipts from them decreased by 2.82 per cent. During the two periods the calorific value of the gas supplied was unchanged. It is important to supplement Mr. Honey's figures with the statement that on inquiry we find that the company changed over from the cubic foot to the therm system about the middle of June, 1921, so that the figures compare fairly accurately the consumptions and receipts for two periods one of which covered the volumetric and the other the thermal system of charging.

The Late Mr. Herbert Miller.

A LINK with the early days of public electric supply in London has been severed by the death of Mr. Herbert Woodville Miller, engineer and manager to the Kensington and Knightsbridge Electric Lighting Company, Limited. In 1886 he was selected from among the pupils at Crompton's Chelmsford works to assist in working out in London the system of electric light distribution which the firm had then just completed in Vienna, and became intimately associated with the working of the Kensington and the Notting Hill companies. He eventually succeeded Colonel Crompton as engineer-in-chief to the Kensington company, and remained with it up to the date of his death. In collaboration with Colonel Crompton, he developed the large accumulator station as the best means of securing continuity of supply, and thirty-five years ago worked out a system of bare copper underground mains for which durability, low cost of upkeep, and small interference with the road surface were claimed. He was also responsible for the introduction of many developments in the steam-raising plant of central power stations, notably in connection with automatic stokers and the late Mr. Druitt Halpin's system of thermal storage.

An Extraordinary Railway Mishap.

ONE of the most curious railway accidents in the history of British railways took place early in the morning of last Friday on the North-Eastern Railway near Stannington. A heavily laden fast goods train for Edinburgh and Glasgow left Newcastle at 1.15 a.m. When passing through Stannington one of the wagons near the front end of the train jumped the rails, but did not turn over. The train continued to travel at about 60 miles an hour for over a mile without either the driver, fireman or guard being aware that anything was wrong. The attention of a signalman was, however, called to the matter by the emission of sparks from the derailed wagon, and the train was duly stopped. But by that time the derailed wagon had got on to the rails again, apparently as the result of striking some points, so that there was nothing to show that anything had gone wrong so far as the train was concerned. Examination of the line, however, showed that over a thousand chairs in rear of the train had been broken. A gang of platelayers and two wagon loads of new chairs were dispatched from Newcastle, and by the afternoon of Saturday full double-line working was resumed.

Tests of Mud Splash Guards.

IN order to afford useful information as to recent progress in the design of mud splash guards for road vehicles and to provide manufacturers and inventors of such devices with an opportunity for having them tested, the Royal Automobile Club some time ago organised trials under the charge of the Club's Expert and Technical Committee. Records were taken of the mud deposited on a white screen when a car fitted with a competing guard was driven past it, and the behaviour of the guard was noted (1) on a short road test (2) when the wheels of the vehicle on which it was fitted were brought into contact with the kerb. Thirty-six entries were received from twenty-three makers, fourteen of the guards being designed for use with pneumatic tires, and sixteen for solid tires. The report of the judges has now been issued, and records that the trials showed that little or no progress had been made in the design of mud splash guards during recent years. The results of the kerb test were disappointing, a number of the guards being either strained, completely removed, or otherwise put out of action, and it was evident that many of the designers completely failed to realise the conditions under which mud splash guards have to be used. On the road test many of the devices gave a poor performance, and three of them became detached. As regards mud-splashing, all the devices succeeded in reducing it, but none reduced it to a negligible quantity. After careful consideration the judges decided not to recommend any award in either class.

Restarting the Ansaldo Works.

THE necessary financial assistance having been provided, the Ansaldo steel works are again to resume their customary activity. The new organisation will take over the principal plants of the former company, among which are the famous Sampierdarena machine shops and locomotive works; the dockyards at Sestri Ponente and the yards at Borzon; the railway car works at Fegiano; the steel works at Cornigliano Ligure; the gun factory and electrical works at Campi; the iron foundry at Multedo; and the steel, bronze and aluminium plants at Cornigliano. The old company is not, however, extinct, since it retains in its ownership the Cogne mines, near St. Vincent; the hydraulic plants at Aosta, and the lignite mines at Murlo, near Siena, as well as the Pa manganese mines near Sassari; the Lauriano Po cement and lime factory, near Turin; the motor car factory in the same city, and the dockyards at Voltri. There will thus be two separate and independent companies, which are expected, however, to work together and strengthen each other financially. With regard to the iron deposits at Cogne, the exploitation of which was one of the largest and most important undertakings entered upon under the pressure of war necessity, renewed activity is already to be noted. The great difficulty here has always been to solve the problem of transporting the ore mined to Aosta, where the electric furnaces are situated. This difficulty has now been overcome after six years' work on a 7-kilometre tunnel through the mountain which previously barred the way. The iron deposits are estimated to exceed 10 million tons, while the ore yields 62 to 65 per cent. pure magnetite of a nature similar to that of the Swedish deposits. It is not improbable that the owners of the mines and their equipment (the property still of the old Ansaldo Company) will offer the whole to some foreign purchaser, permission having been obtained from the Italian Government to this end.

Six Decades Ago.

HAVING had occasion to refer to the issue of THE ENGINEER for December 18th, 1863, we were struck with the prominence which then, as now, was being given to naval matters. First, there was a paper "On the Construction of Iron-plated Ships," read by Mr. (afterwards Sir) W. Fairbairn before the fourth session of the Institution of Naval Architects, in which was recorded the progress made in applying the lessons derived from the experience of the French "iron-cased batteries" in the Crimean War. In the course of this paper it was stated that a long series of experiments had determined that "the material which presents the greatest power of resistance to projectiles at high velocities is the softest and best description of well-wrought malleable iron." Tests on Sir Wm. Armstrong's 600-pounder shunt gun, familiarly known as "Big Will," were being carried out at Shoeburyness against a target representing a section of H.M.S. Warrior's side. The results apparently amazed the onlookers both as regards accuracy and destructiveness. In a note on the subject we find it stated that "since the great battle of gun *versus* plate had begun to be waged there had never been such a complete triumph for the former combatant." The launch of "another magnificent addition to our iron-clad fleet," the Minotaur, from the Thames Ironworks, was recorded, but in spite of its magnificence we notice that it was recognised that it could be sunk without difficulty by two shots from "Big Will." An interesting account was given of the American "Monitors"—reprinted from the *Scientific American*—a topical subject at the time by reason of the manner in which the first of them—the Monitor itself—defeated the rebel steamer Merrimac in the course of a five hours' engagement, and so "materially changed the aspect of our present war."

THE BIRCHILLS POWER STATION OF THE WALSALL CORPORATION

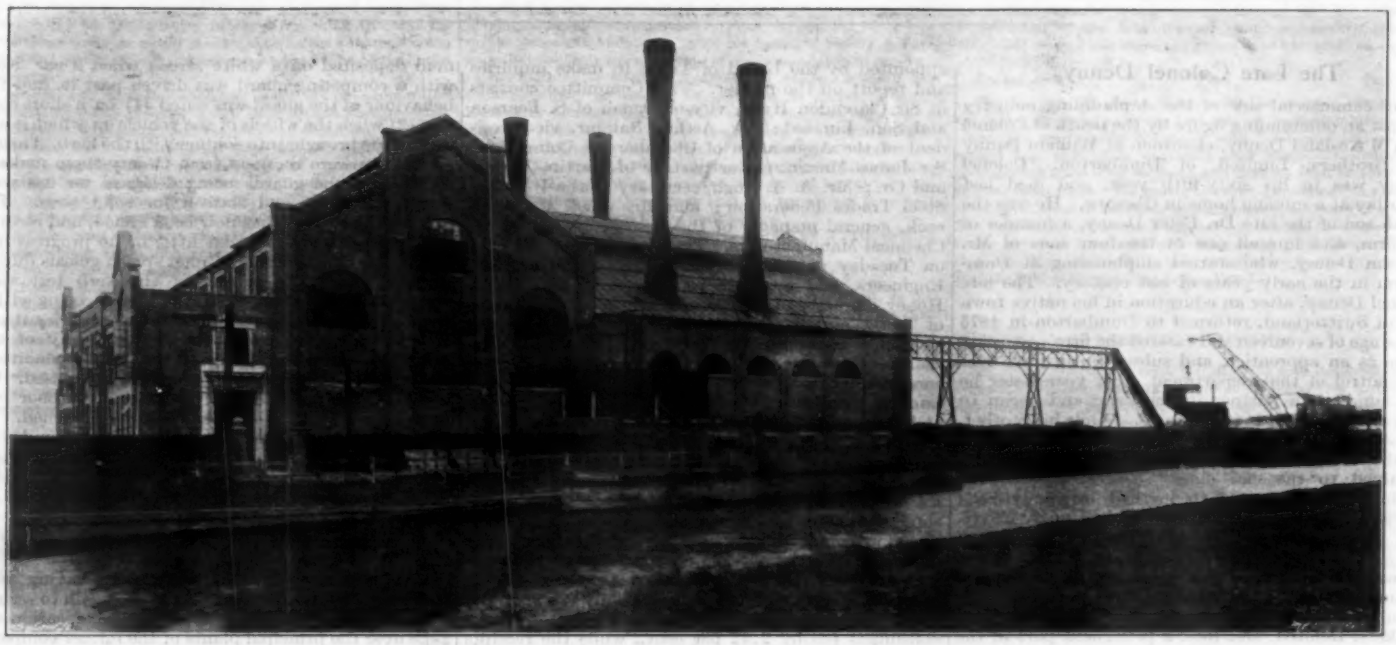


FIG. 1

The Walsall Electricity Undertaking

THE Walsall Corporation was granted a Provisional Order to supply electrical energy in the year 1890, and the undertaking was commenced in 1895. The original generating station was situated in Wolverhampton-street, but in course of time both the site of the generating station and the system of generation and distribution were found to be uneconomical and unsuitable for the growing needs of a large industrial centre. Acting upon the advice of Mr. E. M. Lacey, the Walsall Corporation decided between 1913–1914 to provide a new generating station at Birchills and to change over to a 6600-volt three-phase system. The work was commenced in 1914, when Mr. H. A. Howie was appointed engineer and manager.

A detailed description of the original building and plant of the Birchills generating station was given in a paper read before the Institution of Civil Engineers in March, 1917. The object of the design was to secure the greatest possible economy in constructional and other works and also efficient operation. The Birchills station was erected on the Wyrley and Essington Branch of the Birmingham Canal Company's system, and the cooling water for condensing purposes has, up to a recent date, been taken from this canal. The engineers were not, however, satisfied that the best possible results were being obtained, and came to the conclusion that in order to increase the efficiency of the station and to provide for the rapidly increasing load during the next few years, further provision should be made for obtaining a considerably larger volume of cooling water, either with the aid of cooling towers or from other sources. The results of their investigations was that they recommended the Anson pumping scheme, which is now in operation and is an important feature of the extensions recently completed.

The canal at Birchills is on what is called the Wolverhampton level, and is approximately 63ft. above the level of the canal system through Walsall. In order to maintain the water at the Wolverhampton level the canal company has found it necessary to raise continuously a large quantity of water from the Walsall level. These pumping operations have, on some occasions, so far interfered with the flow of the canal at Birchills as to cause the high-temperature water from the condenser water discharge pipes to bank up to the condenser water inlet pipes, thereby raising the temperature of the inlet water and thus reducing the vacuum.

An agreement was entered into between the Corporation and the canal company under which the Corporation undertook to raise from the lower canal level all the water required for the higher canal level, and for these services an annual sum is payable by the canal company. The agreement also provided that the Corporation will have the power to pass the whole of this water through the condensers at Birchills for a small annual contribution. The total volume of water necessary to maintain the higher canal level is approximately 550,000 gallons per hour, which is more than sufficient for present condensing water requirements at Birchills. In addition to this the canal company has provisionally agreed that the Corporation may, as the necessity arises, pump up to 1,200,000 gallons per hour.

By way of a pipe line some 800 yards long the water is raised to the Birchills generating station and, after passing through the condensers, is discharged to the high-level canal. The high-temperature water discharged at the high level can flow back to the low level, either *viâ* the Walsall Canal system or *viâ* the Wolverhampton Canal system, the distance being approximately 3½ miles in either direction. Only part of the water discharge through the condensers at Birchills to the high-level canal system is returned to the Anson branch. A large quantity is entirely passed away from the Walsall Canal system to the Wolverhampton Canal system, and the water so passed away is made up by the admission of large quantities of cold mine water to the low-level system. Having regard to these conditions, it was calculated by the engineers that the temperature of the water in the Anson branch would not be raised appreciably, and this has been proved correct in practice.

The pumping station building is designed for two pumps, which are shown in Fig. 2, and has a temporary end so that extensions can be made when required for additional pumps. The water from the Anson branch flows to the pump-house by way of an open concrete channel, at one end of which a circulating water screen is erected. This

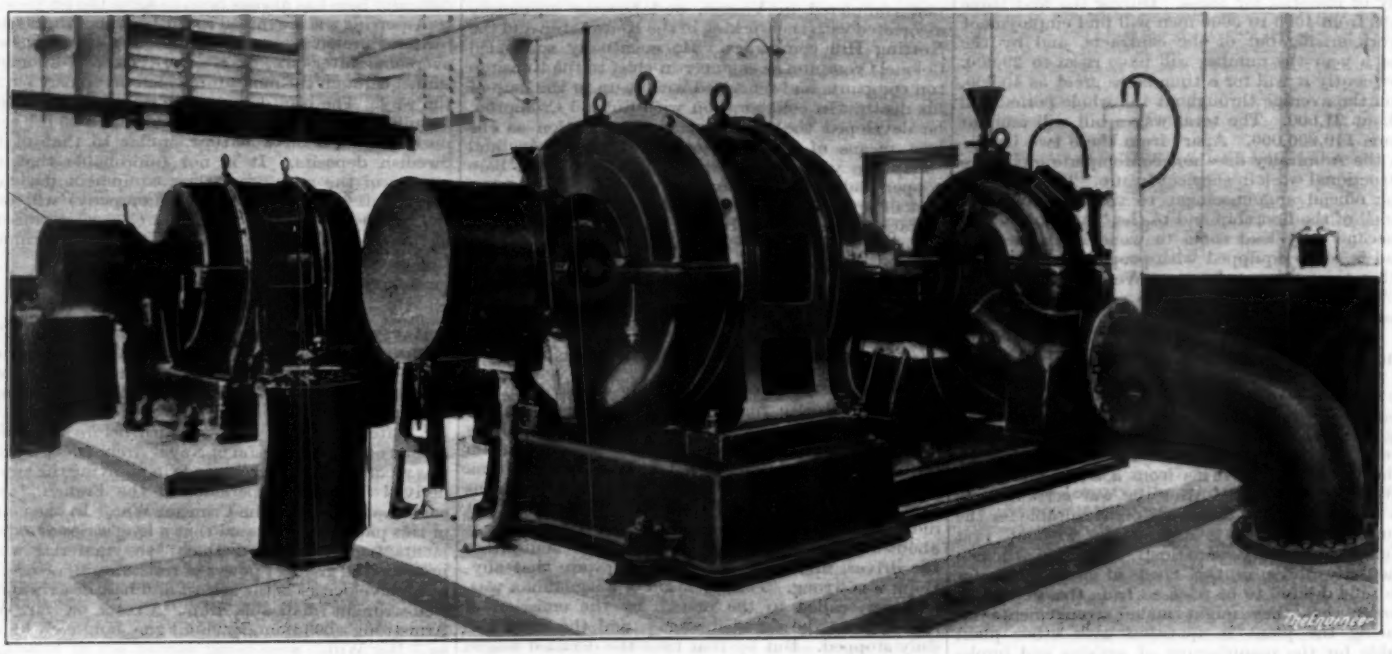


FIG. 2—ELECTRICALLY-DRIVEN PUMPING PLANT

screen consists of a perforated disc 20ft. 4in. in diameter, rotating at slow speed, with cleaning jets arranged so as thoroughly to wash away all weeds and *débris* collected on the mesh. The screen is designed for the passing of 1,500,000 gallons of water per hour.

The pumping plant consists of two Mather and Platt medium-lift circulating pumps, each capable of delivering 7400 gallons of water per minute against a total head of 110ft. when running at a speed of 980 revolutions per minute. Each pump is driven through a flexible coupling by a 330 horse-power, three-phase, 50-period, 400-volt enclosed ventilated slip ring induction motor made by the Brush Electrical Engineering Company, Limited.

The plant capacity of Birchills station—shown in Fig. 1—has been increased by the installation of a 5000-kilowatt Brush-Ljungstrom turbo-alternator working at a steam pressure of 180 lb. per square inch at the turbine

stop valve, 245 deg. Fah. superheat, and exhausting into a vacuum of 28¾in. The set is capable of an overload capacity of 25 per cent., or 6250 kilowatts, for a period of two hours. The turbine is directly coupled to two Brush three-phase, 50-cycle, 6600-volt alternators, having a combined output of 5000 kilowatts at .8 power factor, a view of the set being given in Fig. 3. The turbine is equipped with an auxiliary steam-driven oil pump fitted with a Mason regulator, which is set so as to bring the auxiliary pump into operation when the oil pressure of the main pump falls below a predetermined value.

The turbo-alternator is mounted on a Brush surface condenser having a cooling area of 12,000 square feet and a capacity of 58,500 lb. of exhaust steam per hour. The condenser is supplied with 7400 gallons of cooling water per minute and is capable of maintaining a vacuum of 28¾in. when the cooling water enters at 60 deg. Fah. The auxiliaries of the condenser comprise a four-throw Brush-Edwards air pump driven by a three-phase, 365-volt, 50-period, enclosed ventilated Brush induction motor rated at 42 horse-power and normal load 28 horse-power. A lift pump is driven off the air pump crank shaft for pumping the condensate to the hotwell. Cooling air for the alternators is provided by a Keith-Blackman fan driven by a 50 horse-power Brush enclosed ventilated induction motor. The cooling air is drawn through a Cleworth-Wheal wet air filter which is driven by the fan motor through spur gearing. A Lea recorder for measuring the quantity of condensate is provided, and also instruments for recording the steam pressure, vacuum, inlet and outlet circulating water temperatures, and condensate temperature.

The official trials of the turbo-alternator were made on May 23rd, 1922. The specified steam conditions and vacuum upon which the contractor's guarantee of steam consumption was based were as follows :—

Steam pressure at stop valve	186 lb. per square inch
Steam temperature at stop valve ..	625 deg. Fah.
Vacuum with cooling water at 60 deg. Fah.	28.75in.

Owing to the temperature of the canal cooling water being, on the date of the test, somewhat higher than that stated above, the vacuum was lower than 28.75in. On the other hand, the steam temperature was higher. After making the prescribed corrections for these variations the result of the trial was as follows :—

Load. kw.	Vacuum. in.	Steam consumption in pounds per kilowatt-hour. Measured.	Corrected.	Guaranteed.
2328 ..	28.50 ..	13.56 ..	12.53 ..	13.0
2495 ..	28.25 ..	13.27 ..	12.32 ..	12.8
3942 ..	27.98 ..	11.65 ..	11.14 ..	11.78
4968 ..	27.62 ..	11.48 ..	11.00 ..	11.42
4845 ..	27.40 ..	11.80 ..	11.10 ..	11.42

During the above series of tests on loads ranging from 2328 kilowatts to 4968 kilowatts over a period of eight hours the coal consumption was 2.26 lb. per unit generated, the calorific value of the coal being 10,130 British thermal units per pound "as fired," and the thermal efficiency of the station being 14.85 per cent.

The official trials on May 23rd, 1922, were in every way satisfactory. It was, however, felt that, with the Anson pumping scheme in operation, the steam consumption would be appreciably lower. The contractors therefore asked that further trials should take place, such trials being conducted by the engineers. This course of action was agreed to, and the trials were taken on Wednesday, November 22nd, 1922, under their personal supervision. The measured steam consumption in this case with an average load of 5030 was 10.36 lb. per kilowatt-hour.

During the trials the whole of the commercial load of the station was carried by the Brush-Ljungstrom set over a period of six hours. The load varied from 3700 kilowatts to 5450 kilowatts. The coal consumption was 1.92 lb. per Board of Trade unit generated, the calorific value being 10,160 British thermal units per pound "as fired." The thermal efficiency of the station was 17.49 per cent. No allowance on steam consumption was claimed by the makers for variation of load, and none is included in the above figures.

The plant extensions were carried out in accordance with the specifications and under the supervision of Mr. Lacey, the consulting engineer, and Mr. Howie, the Corporation's electrical engineer and manager, Mr. Bruce Dawson being associated with the building work. Valuable suggestions of Mr. A. W. Willet, chief engineer of the Birmingham Canal Company, led to the adoption of the Anson pumping scheme, and greatly facilitated the carrying out of the scheme. Since the inauguration of the Birchills station a steady extension of the 6600-volt, three-phase feeders, and also four-core, 400-volt distributors, has been carried out, and a gradual change over of distribution from direct current to alternating current has been taking place. Many large works in the borough are now taking a supply from the extra high-tension mains, which have also been extended outside the borough, under Fringe Orders, so as to supply various collieries.

The whole of the extra high-tension mains have been supplied and laid by Callenders Cable and Construction Company, Limited, and an interesting fact in this connection is that the 3300-volt cables which were laid by that company some thirteen years ago, and which have been working at that pressure for some five to six years, have successfully withstood a working pressure of 6600 volts during the past seven years without breakdown or trouble, although the cables were originally designed for the lower pressure.

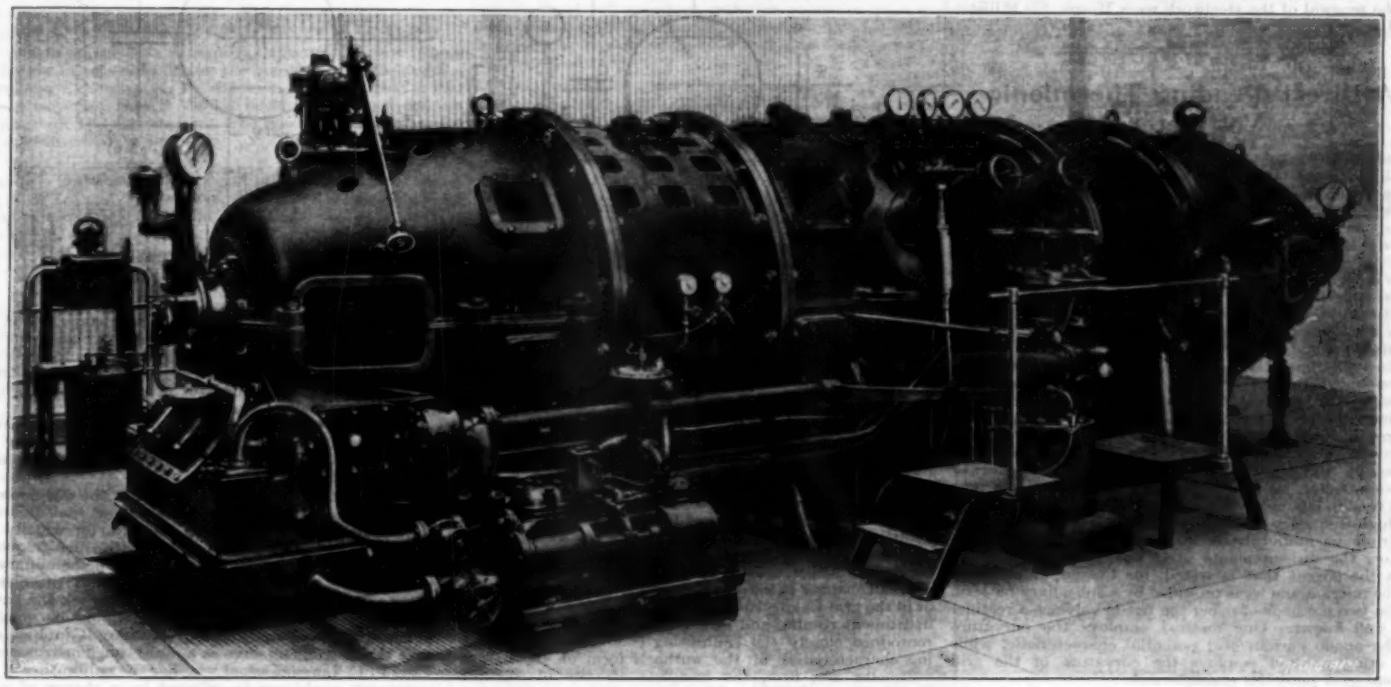


FIG. 3—5000-KILOWATT BRUSH-LJUNGSTROM TURBO-GENERATOR SET

Strengthening of the Floor, &c., of the Forth Bridge.*

By WILLIAM ALEXANDER FRASER, M. Inst. C.E.

THE paper describes the renewal of the inner rail troughs and the buckled plating of the floor of the bridge, the strengthening of the cross transoms of the internal viaducts, and the provision of additional cross bracing between the main girders of the approach spans. The rails which form the up and down lines on the bridge are carried on timber waybeams, laid in four continuous steel troughs. The two outer troughs form the top boom of the main girders of both the north and south approach spans and the internal viaducts. The two inner rail troughs, on the other hand, are carried on cross transoms which span between, and connect to, the side plates of the top booms of these girders. From bay 4 of the cantilevers, where the internal viaduct terminates, to the ends of the cantilevers and across the central spans, the four troughs are carried on cross transoms spanning between the bottom booms of the cantilevers and the main girders of the central spans.

The section of the old troughs was uniform throughout the bridge, with the exception of the troughs over the cantilever ends and central spans, which had a heavier section to suit the wider spacing of the transoms. The troughs were side-stiffened by sloped supports riveted to the troughs and the cross transoms. Buckled plating, with the buckle convex, closed the floor between the troughs, the plates being riveted to the lower flanges of the troughs. The cross transoms are of ordinary plate-web construction, 12in. deep in the internal viaducts and 24in. and 47½in. maximum depth in the approach viaducts and central girder spans respectively. The internal viaduct transoms, unlike the others, have a central support. The maximum spacing of the transoms ranged from 7ft. in the approach viaducts to 15ft. and 22½ft. in the internal viaducts and central spans respectively.

In the course of renewing the timber waybeams in 1906, it was discovered that the bottom plates of the inner troughs were fractured between the rivet holes in many places at the support of the trough on the cross transom, and that a large number of the rivets connecting the trough and transom had worked loose. The horizontal rivets in the cross transom connecting the top angle and web immediately beneath the inner troughs had also worked loose through lack of rigidity in the transom, these rivets having on previous occasions given trouble. The defects were attributed previously to (*a*) the heavier loads passing over the floor of the bridge, and (*b*) the lack of rigidity of the inner troughs as compared with the outer troughs, the destructive effect being accentuated by water and grit discharged from the inside of the troughs. In 1890, when the bridge was opened for traffic, the weight of a locomotive was 77¼ tons, with a maximum axle weight of 15½ tons, whereas to-day these weights amount to 119¾ and 20 tons respectively.

Before the new waybeams were placed, all the loose rivets were cut out, the fractured bottom plates were reinforced with covers placed inside the troughs, and new rivets were inserted. In 1908, while the renewal of the timber waybeams was still in progress, it was evident that the repairs were not likely to prove satisfactory, as a large number of the new rivets had again worked loose. In 1909 it was decided, as an experimental measure, to insert an additional cross transom between the existing transoms at bays 3 and 4 of the cantilevers, so as to give additional support to the lighter inner rail troughs. The provision of these transoms did not, however, provide a remedy for the deterioration at the bearings, which by 1911 had developed to such an extent as to necessitate consideration of further remedial measures. It was decided, therefore, to renew the inner rail troughs and buckled plating on the approach and internal viaducts, to strengthen and stiffen the cross transoms of the internal viaducts, and at the same time to provide additional cross bracing between the main girders of the approach spans so as to brace each panel point, the existing bracing being arranged at alternate panel points only.

The new troughs are constructed of three steel channels 17in. deep, which had to be specially rolled, and which give a very stiff section with a minimum amount of riveting —a matter of considerable importance in a floor of this type. To prevent the percolation of water from the inside of the troughs, a close rivet pitch was adopted, the edges of the bottom channel being caulked. The stresses in the new troughs were calculated on the basis of the latest axle-loading, assuming the troughs to be continuous, and adopting a modified unit stress of 4 tons per square inch. The section modulus of the original troughs for spans up to 15ft. was 100 units as against 137 units in the new troughs, and for the larger spans 184 units as against 197 units. The old type of sloped lateral support, the riveting of which gave considerable trouble, was discarded in favour of a flat right-angled support which, after experiment, was found to be sufficient, and which enabled an efficient connection to be made between the trough and transom without the necessity of riveting the trough and transom directly. This was important in view of the trouble experienced with the rivets connecting the old troughs to the transoms, and was a decided improvement from a maintenance point of view, as in future repairs could be carried out without disturbing the permanent way, which was impossible under the old arrangement.

The strengthening of the internal viaduct transoms and the reduction of shear on the web rivets have been effected by increasing the depth of the transoms by means of additional angles riveted to the lower flange and by providing heavy bosom plates on each side of the web immediately below the inner troughs. The section modulus of the original transom was 35.3 units, while that of the stiffened transom is 87.4 units.

The new buckled plates between the troughs are riveted to the bottom flange of the troughs as before, but the curve of the buckle is reversed. This alteration was made with the object of throwing all *débris* and surface water to the centre of the plates, instead of to the sides as formerly, difficulty having been experienced in keeping the junction

* Official abstract of a paper read at the ordinary meeting of the Institution of Civil Engineers on Tuesday, December 5th, 1922.

of the floor plate and the bottom flange of the trough in a satisfactory condition, owing to lodgment of *débris* and water there.

The work was carried out by means of timber platforms hung from the main girders. The renewal of the troughs and work in connection therewith was done on Sundays, the remainder of the work, which did not interfere with the running lines, being carried out in stages during the week. On Sundays it was necessary to retain one line for traffic, and for this purpose a fully-equipped electric tablet system of single-line working was installed. The up and down lines were closed on alternate Sundays, the troughs in both lines for one section being completed before the work on another section was commenced. An extensive system of temporary horizontal bracing was adopted so that the old floor plates could be cut out and the rivets could be removed during the week, without materially impairing the rigidity of the viaduct under traffic conditions.

The work, the greater part of which was carried out under war conditions, was commenced in May, 1914, and was completed in September, 1920, the number of troughs laid being 340, occupying 145 Sundays.

The approximate weight of old steelwork removed from the bridge was 2400 tons, and the weight of new steelwork used was 3212 tons. The net cost of the work, exclusive of the cost of the work in lifting and replacing the timber waybeams, rails, &c., was £147,299. The contractors for the renewal of the steelwork were Messrs. Sir William Arrol and Co.

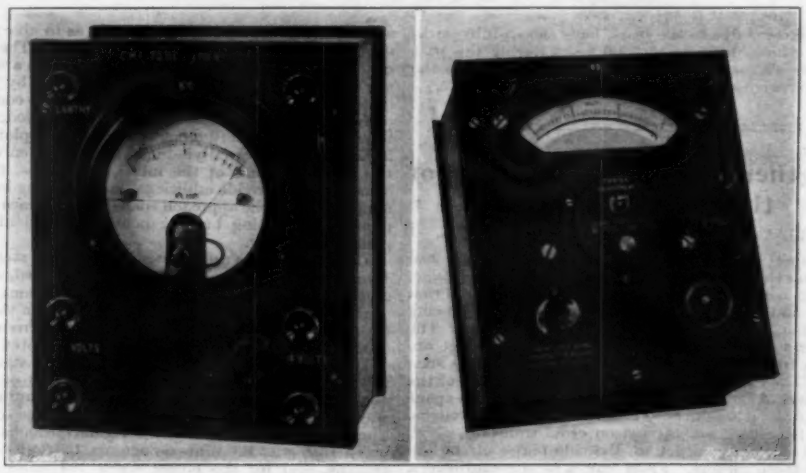
A Direct Reading Thermionic Voltmeter.

Before the wireless section of the Institution of Electrical Engineers, on December 6th, Mr. E. B. Moullin read a paper on "A Direct Reading Thermionic Voltmeter and its Applications." There are many occasions in alternating-current work when it is desirable to measure small electromotive forces of the order of one or two volts, but such measurements are attended with great difficulty in cases in which it is essential that they shall not absorb any appreciable power from the circuit that is being tested. Practically the only instrument hitherto available has been an alternating-current potentiometer, but the use of this is precluded in measurements at high frequency.

The well-known thermionic vacuum tube forms a most convenient method of measuring alternating electromotive forces of any frequency, because owing to its asymmetric conductivity an alternating electromotive force, of which the mean value is zero, produces an alternating current the mean value of which is not zero, and the mean value is readily measured by an ordinary milli-ammeter or micro-ammeter. A rectifier and galvanometer have long been used in laboratory measurements as a rough indicator for high-frequency work. If a suitably arranged three-electrode vacuum tube is used as the asymmetric conductor, the measurements need not absorb any power from the circuit that is tested, for the power absorbed by the micro-ammeter is provided by a subsidiary battery.

The two methods of using the triode valve as a rectifier are well known: One method employs the curvature of the anode current/grid potential characteristic, while the other method employs the curvature of the grid current/grid potential characteristic.

Fig. 1 shows a completed instrument working with grid rectification, and Fig. 3 a diagram of connections. It is found that the calibration is inappreciably affected by small changes of anode or filament voltages, so that there is no necessity to reproduce accurately the conditions obtaining at the time of calibration. Since the change of mean anode current consequent upon the application of a given electromotive force to the grid is sensibly independent of small changes of anode potential, it is possible to adjust for these small changes by means of the zero adjuster of the galvanometer. With the valve switched on and the anode battery connected, the pointer is simply brought to the zero of the scale which in this case corresponds to the full deflection of the instrument. One special advantage of this type of instrument is that it is unaffected by the existence of a steady potential difference between its terminals; it can, in consequence, be used to measure an alternating electromotive force superimposed upon a steady electromotive force of large or small value.



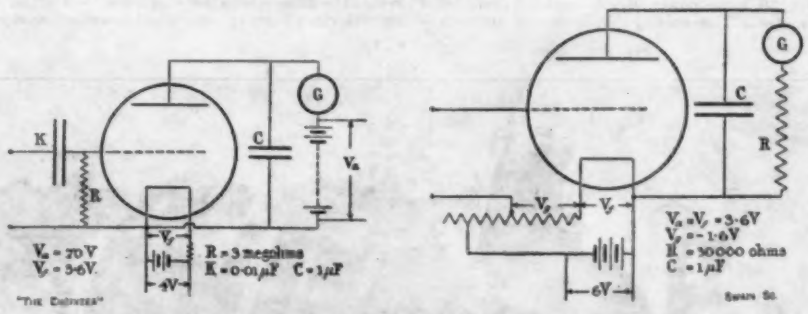
FIGS. 1 AND 2—MOULLIN HIGH FREQUENCY VOLTMETERS

Fig. 2 shows an instrument utilising anode current curvature for rectification. No separate anode battery is employed, and all that is required to complete the instrument for use is a 6-volt filament battery. The instrument is very robust mechanically and, unlike thermo-couples, it cannot be injured by an overload. It is also as easy to use and almost as portable as an ordinary direct-current voltmeter.

Fig. 4 shows a diagram of connections, from which it will be seen that the 6-volt filament battery is not used to apply 6 volts to the filament, but to provide a means of making the grid potential 1.6 volts negative, in order to reduce grid damping to a negligible amount. This method of fixing the grid potential allows it to be made about 0.25 volts more negative than it could have been if a single small dry cell were used for the purpose, and it also obviates the risk of the calibration being upset by the deterioration of a small cell.

In order to ensure an indefinitely long life to the valve, only 3.6 volts are applied to the filament; and this is also the case with the cumulative grid type instrument already described.

The rate of change of mean anode current with respect to alternating grid potential tends to increase and so a high resistance is inserted in the anode circuit with a view to improving the linearity of the scale and thereby increasing the range of the instrument; it does not, however, reduce the sensitivity of the first part of the scale. It is readily seen that, by causing the increasing mean anode current to pass through a high resistance, the mean potential of the anode is decreased by an amount that is proportional to the increase of mean anode current. The rate of increase of mean anode current is lessened by the reduction of anode potential, and by a suitable choice of anode resistance the volt scale can be made as nearly linear as may be desired.



FIGS. 3 AND 4—CONNECTIONS FOR MOULLIN HIGH FREQUENCY VOLTMETERS

The outstanding feature of the author's grid-type voltmeter is that the anode battery is chosen so that the decrease of mean anode current bears a maximum ratio to the anode current produced by the anode battery, thus allowing balance methods to be dispensed with and the instrument dial to be calibrated direct. This is also the condition which makes the calibration sensibly independent of small changes in the electromotive forces of the batteries or in the grid leak resistance. A very simple direct-reading instrument results, and no special care need be taken to reproduce closely the calibrating conditions. The leading characteristics of the author's form of anode type voltmeter are, first, the complete absence of separate anode or grid batteries, the only extraneous apparatus required being a nominally 6-volt accumulator; and, secondly, the exact reproduction of the calibrating conditions by the indication of the galvanometer. So far as the author is aware, the methods of application and construction of both types are original, and he believes that they make simpler and more portable instruments than anything yet described.

The new voltmeter can be used for a number of purposes. It is useful, for example, in constructing high-frequency amplifiers, for the amplification ratio can be directly measured. The grid type of instrument is most suitable for use with resistance amplifiers, for its reading will not be affected by the large steady potential difference in the anode resistance. Among other uses to which the instrument may be put are the measurement of signal strengths in wireless telegraphy, the determination of the power factor of condensers, and the measurement of stray magnetic fluxes. If the grid type of instrument is connected across a resistance placed in the field circuit of an alternator, it can be used to measure the extent of the small alternating current superposed in the steady field circuit, or it may be used to measure the voltage ripples of a direct-current dynamo, whilst with the help of an amplifier it may be employed to measure the extent of cyclic variations of temperature, such as those occurring in an engine cylinder.

In opening the discussion, Professor Fortescue remarked that the principles involved in the design of the instrument were not new, but it had been left to the author to see the possibilities of those principles in the direction of voltmeter design. He thought that the author had been rather too modest in his claims relating to the uses of the instrument. There was only a short paragraph in the paper concerning the use of the instrument for the direct measurement of high-frequency resistance, and the author had not considered the possibility of using the instrument as a wattmeter. There was also a good opening for the instrument for observing the fluctuations of a direct-current supply, but he was not so sure that it was a very suitable instrument to employ for the study of resonance. Possibly there were one or two questions which had to be settled before the instrument could be considered perfectly satisfactory. The conditions of the grid and filament might, he thought, lead to differences in the characteristics of the instrument, and long experience was necessary before users could feel quite safe in relying upon its accuracy. Some sort of screening might be necessary in order to avoid troubles arising from stray capacities.

Major H. Lefroy thought that the instrument was the most useful that had been produced for high-frequency work, and that it would enable various points to be settled which could not be settled before. It would, he considered, be very useful to amateurs, for it would enable them to study signal strength, &c.

Dr. E. H. Rayner referred to the different characteristics of valves, and said that valves produced by the same makers did not by any means have the same characteristics.

Mr. J. Hollingsworth considered that the development of a small and portable instrument such as that described in the paper was a great step forward, for usually the measuring instruments associated with high-frequency work were more elaborate than the rest of the apparatus. It was necessary to ensure, however, that the characteristics did not change. He would like to ask the author whether he did not consider that it would be possible, by changing the value of the resistance R in Fig. 4 to make the instrument serve as a multi-range instrument.

Mr. F. C. Lunnon asked whether the calibration of the instrument would not be affected by a change of wave form. The author had rather discredited the slide-back method of measurement, but the errors were practically constant over a wide range of voltage. It was not, however, suitable for such low voltages as the author's instrument. One great advantage of the slide-back method was that it definitely measured peak voltages. In suggesting that the new voltmeter might be used for measuring signal strength, the author had, he thought, overlooked the effects of atmospherics.

Major Binyon remarked that during the war many valves were broken before they were put into use, and he thought it would be a distinct advantage if the risk of breakage could be reduced. Would it not be possible, he asked, to produce a valve with an exceedingly large filament which would not break.

Mr. Reginald Clinker wound up the discussion with a few remarks on the need that had always existed for a meter that would read a fraction of a volt on a high-frequency circuit, and referred to various applications of the instrument.

In replying to the discussion and referring in the first place to the measurement of high-frequency resistance, the author said that he had measured aerial resistances with perfect success. The instrument might, as the first speaker had suggested, be employed as a wattmeter by using it in accordance with the three-meter principle. For resonance investigations the slide-back method was possibly the best in certain cases. He could not give a definite reply to the question that had been raised in respect of the ageing of the filament, but he had taken the precaution of only applying 3.6 volts to the filament. Since March he had had the instrument under constant observation, and had been unable to detect any alteration in its accuracy. He did not think that changes in the condition of the filament was a matter of much importance. Whilst he did not wish to discredit the balance method of measurement, it would be agreed, he thought, that it was not so easy to use as the instrument which the paper described. Referring to Dr. Rayner's remarks, the author said that every instrument was calibrated individually. Very violent changes of wave form would be necessary to affect the instrument. He did not agree with the practice of altering the value of the resistance R, shown in Fig. 4, in order to vary the range of the instrument. One speaker had referred to atmospherics giving trouble when using the instrument, but in practice no such troubles occurred. A telephone could be connected in circuit with the instrument to enable the experimenter to listen in and so detect the presence of atmospherics. The use of special valves with exceptionally heavy filaments appeared to be a good idea, and it might, he thought, be worth while approaching makers with a view to getting them to supply valves of that description.

The instrument is being made by the Cambridge and Paul Instrument Company

Railway Matters.

THE Railway Amalgamation Tribunal has approved of the preliminary scheme for the formation of the Southern and London and North-Eastern Groups.

THE report of the Commission appointed by the Irish Northern Parliament to consider the future of the railways in Ulster was issued on the 9th instant. We hope to review it in an early issue.

THE Ministry of Transport has issued, through the Stationery Office, a White Paper (Railway Companies' Staff), price 1s., showing the number of persons employed by the several railway companies on March 25th last.

A NORTH BRITISH passenger train, running on Saturday last between Linlithgow and Manuel, on the Edinburgh-Glasgow main line, struck two horses which were straying on the line, with the result that the engine was derailed.

THE Government inquiry into the Birkenhead Park collision of the 6th instant was conducted by Lieut.-Colonel Mount on Tuesday last. At the request of the representatives of some of the men concerned the inquiry was not held in public.

THE reductions that are to be made in the Underground fares on January 1st are considered by the Rates Advisory Committee as sufficiently meeting the circumstances of the case at the present time. The Committee is to report further in the course of the early months of next year.

ASKED on the 30th ultimo by Captain Wedgwood Benn whether he was considering the question of abolishing the Ministry of Transport, Mr. Bonar Law replied that it had been arranged that it should be abolished at a definite time, and the Government was considering whether its abolition could be hastened.

THE Commission appointed to inquire into the proposed railway line between Rotorua and Taupo, North Island of New Zealand, has reported that the line, which will be 54¼ miles in length, could be constructed at a cost of £700,000. This amount would include the cost of stations, but not of rolling stock, which is estimated at £50,000.

THE survey of the section of the Mexican National lines of railway between Monterrey and Corneros, which it is proposed to electrify, has now been completed, and the signature of the President of the Republic is all that is needed in order to put the scheme into effect. The Technical Department of the National Railways of Mexico are engaged upon studies with a view to installing wireless telegraphy upon the whole of the trains run by the Government.

SPEAKING on the 30th ultimo in the debate on unemployment, Sir Montague Barlow, the Minister of Labour, said that the railway companies had responded in the most helpful way to the Prime Minister's appeal to press on with their development work. The contemplated programme involved an expenditure of five million pounds, with further work in view which would cost two millions. As grouping proceeded they would be able to enter upon further developments.

THE South Wales Coalowners' Association points out that the reduction in the charges for the carriage of coal, operative from the 1st instant, follows a very substantial increase in the volume of coal traffic. The total output has increased, month by month, from over 17 million tons in June to an estimated 23¼ million tons in October, and therefore it is erroneous to assume that in conceding these reductions the railway companies are making substantial sacrifices in revenue.

THE Colonial Committee of Parliament has reported favourably on the convention concluded between the Government of Belgium and the Congo Railway Company granting an extension of the concession for a period of twenty-five years. The competent committee has approved the Bill authorising the administration of the Belgian Congo to give a guarantee for the issue of preference shares to the value of 75 million francs for development work on the Katanga section of the Congo Railway.

TENDERS are being invited for the construction of about 30 miles of railway by the Canadian National (Government) Railway directors to connect the Canadian Northern and the National Transcontinental systems at their nearest point of approach, which is 866 miles west of Montreal. When this short link is completed transcontinental trains, instead of travelling north over the Ontario Government line between North Bay and Cochrane, will proceed on the Canadian Northern line through to Sudbury and thence on to the new point of connection with the National Transcontinental.

IN addition to the board of directors of the London, Midland and Scottish Railway Company there are to be committees which may comprise persons other than directors, but who are proprietors to the extent of a director's qualification. These committees will have such powers as the board of directors may, from time to time, confer upon them. It is intended that such a committee, which will include the directors from the three Scottish companies, will be set up for Scotland. It is expected that when the amalgamation of all the constituent companies of the group is completed this committee will consist of twelve members.

IN his paper on "Intermediate Block Signalling," read before the Institution of Railway Signal Engineers on the 6th instant, Mr. C. Carslake showed how a long block section on the up line between Whetstone and Ashby Magna, on the Great Central Railway, had been divided by intermediate automatic signals. Heavy mineral trains used to take twenty-five minutes to traverse the distance in question, but now they pass over it in about the same time as over the adjoining sections, and thus the carrying capacity of the line in that vicinity is increased 100 per cent. Similar divisions have been made on the down line immediately south and north of Hucknall Town. In the discussion which followed it was seen that the cost was against other companies doing likewise; but Mr. Bound, the Great Central signal superintendent, said that the cost was only twice as much as that of an intermediate signal-box, and that the resultant savings were such that the extra cost was recouped in three or four years.

Notes and Memoranda.

IT is reported that Mr. Charles Steinmetz has stated that by employing mercury vapour instead of steam in turbines, the turbines may yield from 40 to 60 per cent. more power with the same fuel consumption.

TRIALS carried out on the experimental test road at Pittsburg have shown that a reinforced concrete pavement 6in. thick will bear the passage of a 50-ton load carried on two wheels. The wheels were, we should judge from an illustration in the *Engineering News-Record*, about 4ft. in diameter, and had solid steel tires 10in. wide.

IN the Bird Lake district in Manitoba indications have been revealed of millions of tons of high-grade copper ore. The area in which this copper has been discovered is within 18 miles of rail, with easy access by water, and only 14 miles from the plant of the Manitoba Power Company. Assays of samples of ore analysed show from 20 to 27 per cent. copper, with a valuation per ton placed as high as 81.13 dols.

THE Institute of Metals has decided on the admission of student members. The main qualifications required of the new class are that they shall be between seventeen and twenty-five years of age, and that they shall be studying metallurgy; they will be admitted to all the usual privileges of full members with the exception that they cannot vote at meetings. Both the entrance fee and the annual subscription are substantially less than those paid by members.

THE number of blast furnaces working in France on November 1st was 109 out of a total of 227, and the production of cast iron during October amounted to 503,443 tons or 42,000 tons more than in September. Steel was also produced in greater quantities, 429,854 tons, as compared with 406,646 tons in the previous month. From January 1st to October 31st, the metallurgical production of France amounted to a total of 4,101,758 tons of cast iron and 3,643,203 tons of steel.

MACHINE bearings of limestone enclosed in white metal are reported, in the *Chemical Trade Journal*, to have given remarkable results in Germany. The white metal is poured into a mould around the limestone, and the latter is then bored with a diamond tool. The porous stone absorbs oil, the bearing becoming quickly polished in use. Tramcar bearings of white metal give a service of only 6000 to 7000 miles, but the limestone bearings are reported to have had a life of 35,000 to 45,000 miles.

THE production of pig iron in Canada during October, according to a report of the Bureau of Statistics, amounted to 36,888 tons, as compared with 24,974 tons in the previous month. During the ten months ending October the average monthly production of pig iron was 31,287 tons this year, as compared with a monthly average of 50,673 tons in the same period last year. The output of steel ingots and castings in Canada during October amounted to 52,735 tons, an increase of 35,787 tons over the September production.

CANADA has huge quantities of copper-bearing ore as yet untouched, in most cases owing to its geographical position. The principal reserves are in British Columbia, Northern Manitoba, and the North-West Territories. Present production is largely from the Sudbury district, Ontario, and British Columbia. Production in 1921 was 53,467,795 lb. Canada produces 80 per cent. of the world's nickel, all from the Sudbury district. Ore reserves now known ensure an established industry for the next fifty years.

A DISCOVERY which is at least of considerable archæological interest, and which may also prove to be of commercial importance, has been made, according to the *South African Mining and Engineering Journal*, in the Waterberg to the east of the Crocodile River, South Africa. Mr. Coucom has unearthed at a shallow depth a portion of what is apparently an old smelting plant and a quantity of slag. These relics evidently formed a portion of a crude smelting plant, and their antiquity seems pretty clear from the fact that close to the spot where the ancient smelter stood there is an old working in which trees of great age are growing.

BROWN coal and lignites are characterised by the following properties, which, taken together, differentiate them completely from the geologically older bituminous coals: (1) In the raw state they contain a large amount of water (generally more than 20, and sometimes even as much as 50 per cent.); (2) on losing the same by air drying they usually disintegrate, either crumbling to powder or developing well-marked laminated cracks; (3) they are naturally devoid of coking properties; (4) in the dry-ashless state they usually contain less than 75 per cent. of carbon and more than 20 per cent. of oxygen; and (5) on carbonisation at 900 deg. they yield upwards of 45 per cent. of volatiles. Their physical texture varies considerably, but is easily distinguishable from that of bituminous coals. Thus, the most recent brown coals have either an amorphous earthy character or a very woody and fibrous structure, while the older varieties have either a laminated structure or a well-marked conchoidal fracture.

SPAIN was the principal lead-producing country until 1897, when it was surpassed by the United States. Although some of the districts have been worked out and others are fast approaching exhaustion, some that have been worked out in depth are again yielding ore from the upper abandoned levels. Moreover, the construction of railways has stimulated production in less accessible districts. La Carolina has increased its output very notably since 1906, when the railway was built connecting it with Linares. In 1913 the Linares-La Carolina district produced nearly one-half of the lead ore mined in Spain. La Carolina, being the younger, produces four times as much lead as Linares. Spanish lead reserves appear to be ample to maintain the present rate of output for a long time to come. The United Kingdom took 41 per cent. of the average pre-war exports, Belgium 16 per cent., France 12 per cent., and Germany 8 per cent. In 1921 Spain sent 62 per cent. of its reduced exports to the United Kingdom, 3 per cent. to Belgium, 10 per cent. to France, 5 per cent. to Germany, and 9 per cent. to the Netherlands.

Miscellanea.

IT is proposed to organise an International Gas Exhibition, to be held at Amsterdam from October 13th to November 11th of next year.

A PROPOSAL has, it is reported, been placed before the Mexican Secretary of the Treasury to impose a poll-tax of 2 dols. (4s.) per head on all residents of the Republic for the purpose of obtaining the necessary funds for the building of roads, which are much needed.

THE migration of Polish miners from the Ruhr pits to the North of France is reported to have re-started at an increased rate, particularly of hewers. It is feared that the result will be to check the desired increase in coal production in the Ruhr, as it is difficult to replace hewers at the rate they are leaving.

COMMUNICATION by wireless telegraphy was established on December 5th between France, Algeria and Tunis, on the one part, and Syria, Palestine and Egypt on the other part. The charge per word has been fixed at 1.30f., and urgent telegrams at triple rates. Press telegrams and telegrams at deferred rates are also accepted.

AN important discovery of native silver is reported to have been made in the Churchill River district of Northern Manitoba. It is claimed that the ore is unlike any hitherto discovered on the continent. Rich samples have been displayed, and it is reported that mining engineers in Winnipeg have been considerably impressed.

IT is reported from Capetown that Mr. McLellan, an engineer of the Marconi Company, has been charged with the construction of the new South African wireless station, which, it is stated, will be the biggest in the world, and will give a direct service to practically every country in the world. Work will be started immediately the agreement has been ratified by Parliament, and it is expected that it will be completed in eighteen months' time. All the material possible will be purchased in South Africa.

WE regret to have to announce the death of Mr. B. S. Broadhurst, which took place on Monday last. As managing director of the Brush Electrical Engineering Company, Limited, with a total period of service in that company in various capacities extending over forty years, Mr. Broadhurst was held in universal esteem, and to his many friends the untimely death of a man of such apparent robust constitution must come with a shock. His health had been giving anxiety for some three or four months, and unfortunately the diagnosis of a deep-seated internal growth was such as to make any successful operation impossible.

WE hear that the first steps have been taken towards the establishment of an international telephone authority on the lines suggested by Mr. Frank Gill in his recent presidential address to the Institution of Electrical Engineers. M. Paul Laffont, the French Minister of Posts, Telegraphs and Telephones, proposes shortly to invite the technical administrators of the western European countries and of the Mediterranean seaboard to consider the question of establishing on a commercial basis a practical system of long-distance telephoning on the international trunk lines. It appears from a recent article in *Le Matin* that the greatest interest has been taken in France in Mr. Gill's proposals, and M. Laffont feels that from her geographical position she should make the first move.

IN an address on "Illuminating Engineering in Relation to Architecture," read before the Royal Institute of British Architects recently, Mr. L. M. Tye urged closer co-operation between architects and engineers responsible for lighting. There were, he said, three methods applied to the lighting of interiors: direct, semi-direct, and indirect. By direct lighting with prismatic reflectors it was possible to redirect 70 per cent. of the total light immediately to the working plane, whilst transmitting in addition 20 per cent. for the illumination of walls and ceilings. The use of a ceiling as a reflector was unscientific, and the results unbalanced. In the lecturer's opinion the solution rested in a return to units of a direct character. Already several most promising new units were available.

THE report of Sir George Buchanan on the Kosi Bay project for providing South-East Africa with a new port has been presented to the Government, but is not likely to be published before Parliament assembles. It is common property, says the *S.A. Mining and Engineering Journal*, however, that Sir George does not favour Kosi Bay as an outlet for Union trade, although he recognises its potentialities in the event of the necessary money to develop it being available. Sordwana Bay seems to be regarded as quite good enough to satisfy the requirements of the export trade, and at a much smaller outlay than would be imperative if Kosi Bay were decided on. The natural advantages of Sordwana Bay are enormous in view of the fact that loading by means of shoots would be possible there, whereas the same work would necessitate the erection of costly and complicated machinery at Kosi Bay.

THE Parisian newspaper *Excelsior* reports that a new machine for printing stamps has been installed by the French Postal, Telegraph and Telephone Department. The machine, which is called the "Petite Chambon," has given such satisfaction that several more are to be constructed to replace those now in use. The new machine consists of a metallic table supported by a central metallic foot. Under the table are placed the electrical equipment, starting switches, &c. The printing roller is similar to the rotary cylinders used for printing newspapers, but only 24 cm. wide. The band of paper previously gummed is seized and manipulated by six or more rollers. The first imparts a proper direction to the paper, the second prints it in one colour, the third only being used in case it is desired to use two colours. The first rollers also number the edges of the sheets. The fourth performs the perforating process without stopping the band. The fifth adjusts the band, which is cut by the sixth. The sheets fall in hundreds into a metal basket, which is carried off by a little *trottoir roulant*. Working normally, the new machine is said to print, perforate, number, cut, count and make up into bundles 3000 sheets of 100 stamps each hourly, or 300,000 stamps an hour. To work it only two men are required, as compared with twelve in the case of machines used up to the present.

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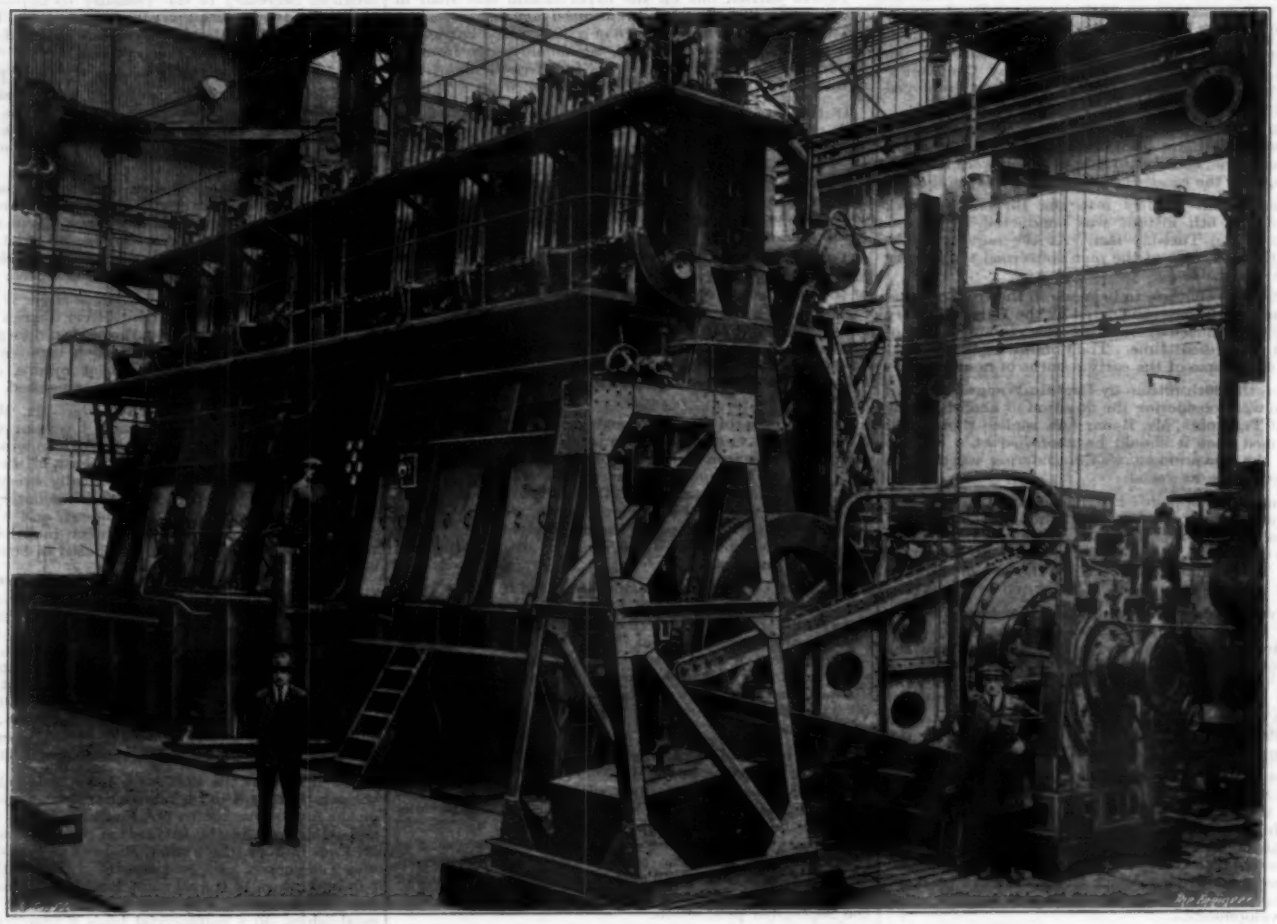
(*For description see page* 624)



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THE ENGINEER.

DECEMBER 15, 1922.

Fatigue.

THE paper on "Fatigue," read to the Royal Aeronautical Society on Thursday last—December 7th—by Professor C. F. Jenkin, of Oxford, and reprinted in full in last week's issue, marks a very distinct step forward in our knowledge of this most important subject. Professor Jenkin's own contribution to this forward step consists mainly of a very ingenious model, which is likely to prove exceptionally useful in the interpretation of fatigue data and a small but important extension of a theory which has been long advanced by other workers. It is fortunate, perhaps, that these advances have been made under the auspices and even under the immediate direction and inspiration of a panel of the Aeronautics Research Committee of the Air Ministry. This fact ensures that, so far as aircraft engineering is concerned, full and immediate advantage will be taken of the new knowledge and new methods which have become available. Even in that small but advanced branch of engineering this will be a notable achievement. In wider circles, among engineers and designers of machines and structures of a rather less exacting nature, it is always a matter of considerable time before new facts are appreciated or new methods adopted. Yet this particular advance, although brought about by the efforts of those directly concerned with aircraft, is of great general importance.

The most fundamental part of this advance in our knowledge of the nature of "fatigue" or failure under alternating stresses is the new understanding which it has brought us of the real relationship between the "elastic limit," or limit of proportionality as determined in an ordinary tensile test by means of an extensometer, and the true "elastic range," as determined by permanent resistance to alternating stresses. It seems that the ordinary "static" elastic limit has little real meaning, as it is dependent to a very large extent upon some sort of internal stress which affects the individual crystals of which a metal is built up. If some of these crystals are self-stressed to a sufficient extent, the "static" elastic limit may be very nearly zero. Yet such a material, if gradually subjected to increasing load under alternating stress, shows a "fatigue range" of very considerable magnitude. Apparently the process of rapidly repeated loading and unloading relieves or equalises the internal stresses, and after such treatment the metal exhibits a definite elastic range even under "static" loading. Facts of this kind have recently been discovered in very pure copper, and it is the merit of Professor Jenkin's model that it affords a ready explantion, upon the basis of previous knowledge, of the manner in which the crystals of metal behave under either static or alternating stress. But the new knowledge goes much further, since it has been found, and can be readily explained by means of Jenkin's model, that exposure to a suitable system of alternating stresses can be made to raise the fatigue range of a piece of metal—including steel—by something of the order of 20 per cent. in a real and permanent manner, while—on the other hand—unsuitable treatment can cause a real and permanent lowering of the fatigue limits. Here, new and important possibilities are opened up. We have gradually grown accustomed to processes of heat-treatment whereby our materials are very considerably improved; the new discoveries do not in any way lessen the importance of the correct thermal treatment of steel and alloys, but they show that, if the best results under alternating stresses are to be attained, a definite type of mechanical treatment is also required. In many cases, fortunately, the gradual manner in which machines and engines are brought into use serves this very purpose, but the application of the treatment has hitherto been accidental and not consciously purposeful, nor were its advantages appreciated by the designer. Now that the nature of the processes at work in these operations is better understood, such treatment will come to be definitely applied, and designers will be able to rely upon material thus improved. Further, by no means the least of the recent advances in the subject under discussion is the development of a method of fatigue testing which allows the real fatigue range to be determined, in most materials, by a single test. This is the so-called "strain-load" system of alternate-stress testing which, although originated some time ago elsewhere, owes its recent development to the work of Mr. Gough, one of Dr. Stanton's staff at the National Physical Laboratory. The real reliability of this method—the first description of which appeared in our issue of August 12th, 1921—is steadily establishing itself; so much so, indeed, that its indications are in many cases to be definitely preferred to those of the ordinary endurance test. It has recently been found that under an endurance test, a specimen which has successfully endured even 60 million reversals of stress may yet break if the test is continued. Endurance testing with such enormous numbers of reversals is, of course, impracticable except as an occasional research experiment. The "load-strain" method, on the other hand, is likely to become simplified to a point at which it will become almost a workshop test, and certainly one which it will be no manner of hardship to embody in a specification.

If, as there is every reason to think, the anticipations outlined above are fully realised in practice, the bugbear of fatigue failures should largely disappear. It will, at all events, be the fault essentially of the designer and user if he does not assure himself that proper precautions have been taken to guard against such failures. At present, mysterious cases sometimes occur, but the advance of our knowledge suggests the ways in which these have been brought about. As one example, we may take the existing practice of annealing certain objects, such as crane hooks, gas cylinders, &c., in order to "restore" them after they have been exposed to fatigue stresses for a time. It has always appeared to us that such treatment was of doubtful value, if only on account of the risk that the annealing process might in reality merely ruin the internal structure of the steel. Now, however, it is plain that there are circumstances in which such annealing is very definitely wrong from the "fatigue" point of view. Objects, such as those we have mentioned can, it is clear, be rendered specially resistant to fatigue by suitable exposure to alternating stresses; in service such improvement may occur in a natural manner. If, after such treatment, the metal is heated to an annealing temperature, all this improvement is undone and, if the next sequence of loading operations happens to be unfavourable, fracture may result. The correct procedure would be first to "normalise" such objects by heating to a suitable temperature, followed by fairly rapid cooling. Then, having previously determined the proper stress ranges for the material in question, these objects should be "fatigue hardened," as one might term it, by suitable sequences of loading, unloading and rest. After that, however, any further heat-treatment should be strictly avoided. Such a specification of treatment naturally sounds strangely to those who have not followed closely the recent work on this subject. The facts, however, are extremely well substantiated, and there can be little doubt that some such process as that suggested is the

right one, and that similar courses can and should be followed with advantage wherever resistance to fatigue is important.

The Battleship Programme.

It is reassuring to learn that the new Government has decided to carry out the programme of naval construction which had been adopted by its predecessor. For the greater part of this year rumours have been current with regard to the fate of the two capital ships which this country is empowered to build under the Washington agreement. We were told, first, that both vessels would be abandoned; then, that only one keel would be laid within the near future, the commencement of the second ship being deferred until the nation's finances were in a more promising condition. Only recently Admiral Sir Percy Scott was congratulating the Naval Staff on its decision not to proceed with the ships, which he, together with a few other retired officers, persists in regarding as useless and wasteful luxuries. That is clearly not the opinion of the Navy as a whole, nor is it shared by the Government, for, as the Prime Minister announced on Monday, the two battleships are to be laid down, and the work is to be put in hand with the least possible delay. We ourselves never anticipated any other decision, knowing as we did the Admiralty's unshaken faith in the supremacy of the capital ship and its insistence on the necessity of building two additional vessels of this type if the One-Power Standard were to be maintained. In spite of the expense involved, the country, we think will applaud this decision, recognising as it does the undiminished importance of sea power for the defence of our coasts and the protection of our world-wide trade. The country, moreover, has sufficient confidence in its naval advisers to accept their judgment in the technical controversy as to the future status of the great ship, the more readily because they are officers with personal experience of modern warfare, the First Sea Lord having commanded for two years the mightiest aggregation of floating power the world has ever seen. The Grand Fleet, it may be recalled, was not composed of battleships alone. Submarines, aircraft, and other new weapons were well represented in its organisation, and the value of each arm for the strategical and tactical functions devolving upon the British Navy could thus be appraised at first hand by the senior officers of the fleet. It is well to bear this fact in mind when listening to the arguments of the anti-battleship school, which consists for the most part of officers who, never having commanded a modern fleet either in war or peace, are dependent on theoretical or obsolete data. To those who are in touch with current naval opinion nothing is more significant than the unanimity with which all ranks, junior as well as senior, deprecate the anti-battleship agitation as ill-timed and misleading. If Sir Percy Scott's oft-quoted midshipman is still on the active list, he lives, we fear, in a state of intellectual isolation, for it is rare indeed to find any officer, however junior in rank, who does not hold the battleship to be an indispensable unit of our future fleet.

Naval policy must always be dictated primarily by considerations of strategy, to which all other factors are subordinate, and for this reason we dissent from the opinion expressed in some quarters that the Government, in deciding to begin work on the two battleships, was unduly influenced by a desire to relieve unemployment. It is true, however, that the contracts have come at a most opportune time. They represent a total expenditure of £14,000,000 to £16,000,000, spread over three years, and of which over 75 per cent. will be paid out in wages. Some idea of the magnitude of the work involved in the construction and equipment of a modern capital ship was conveyed by Mr. Amery's reply to questions in the House of Commons a week ago. Five hundred firms, he estimated, would benefit from the two contracts. Besides the shipyards where the hulls are built, the shops where their main propelling engines are constructed, and the gun factories and steel plants whence their armament and protective plating will be derived, firms all over the country will be engaged in manufacturing other items of their equipment. They will also bring new work to the mines, the railways, and the shipping industry. It would, in fact, be difficult to name offhand a single trade that will be unaffected by the stimulus which the ordering of these two ships will impart to the nation's industrial system. For the first three months from the laying of the keels 4000 to 5000 men will be employed, increasing to an average of 13,000 within six months, to 29,000 during the second six months, and subsequently rising for a time to 40,000. Such are the figures given by the First Lord of the Admiralty, and all who are familiar with the ramifications of a big naval contract will agree that he did not exaggerate. They serve to remind us of the heavy loss that trade sustained when the four battle-cruisers of the 1921 programme were countermanded rather more than a year since, in deference to the limitation scheme then being negotiated at Washington. Those four ships would have done much to tide the shipbuilding and kindred industries over a very critical period; but when for reasons of high policy the programme was dropped, the blow was accepted with admirable philosophy by the interests concerned. The present contracts are much less imposing, calling as they do for only two ships of 35,000 tons each, in place of the original four ships of 47,000 tons each. It is announced that one hull will be built by Armstrongs on the Tyne, and the other by Cammell-Lairds on the Mersey, who will also construct the Brown-Curtis turbines for that vessel, whilst the engines and boilers for the other will be built by the Wallsend Slipway and Engineering Company, Limited, on the Tyne. Sheffield, Manchester, Barrow, Glasgow, Darlington, and Woolwich will all receive orders for guns, mountings, armour or equipment, and subcontracts will no doubt find their way to other centres. It is estimated that about £4,000,000 will be spent on Tyneside and the same amount in Sheffield, whilst Glasgow will take £1,500,000 and Merseyside £1,250,000. The fact that the Clyde gets a relatively small portion of the present contracts is attributed to the high quotations by Scottish firms. The cost of the new ships has been officially estimated at £6,500,000 apiece, or £8,000,000 apiece when fully completed for service, with all stores, ammunition and accessories on board. Compared with preceding types they will be very expensive ships, the Queen Elizabeth, of 27,500 tons, having cost approximately £3,000,000, and the Hood, of 41,200 tons, about £6,025,000.

No particulars of the design have been disclosed as yet, but we shall be safe in assuming armour to be the item mainly responsible for the increased cost per ton. The ships are not likely to be remarkable for high speed; it will be enough if they are equal in this respect to the swiftest battleships abroad, which are credited with 23 knots. In re-drafting the design from a battle-cruiser to a battleship basis our constructors have certainly endeavoured to preserve as far as possible the gun-power and resisting qualities of the original concept. If the triple turret has been retained it should be feasible to mount nine 16in. guns in each ship, that being the armament proposed for the battle-cruisers. The armouring, both vertical and horizontal, is expected to be far more massive than the Hood's, though even in that ship the protection accounts for 34.5 per cent. of the total displacement; and the defence against under-water attack will, no doubt, be as perfect as the ingenuity of our constructors can make it. An observation in the First Lord's statement on the Navy Estimates for 1921, *apropos* the ships then contemplated, may be taken as applicable to the two modified vessels about to be laid down:—"The Admiralty are fully alive to the necessity of keeping pace with the development of other types of vessels and other weapons which become an increasing menace to the capital ship, and in the design of the new ships it is necessary to improve their offensive and defensive powers against such new dangers as they may have to meet." Provided the Washington agreement is ratified, and that nothing occurs in the interval to necessitate a revision of its terms, these two are the last capital ships that will be laid down in this country for ten years. They are intended to meet the naval requirements of the immediate future, and from that point of view the money spent upon them will be a sound investment.

THE ITALIAN AUTOMOBILE INDUSTRY.

During the first nine months of this year the output of motor vehicles in Italy decreased considerably. In the early summer, some of the makers reduced their working hours from forty-eight to thirty-two per week, and have since been working temporarily four eight-hour days per week. The decline in production has ensued in spite of the Government having reduced by 50 per cent. the taxes on passenger cars for the current year, and notwithstanding the fact that a considerable reduction has also been made in the taxes on motor lorries.

Thirteen of the most important Italian automobile manufactories have their establishments in Turin. Their present production is approximately 43 per cent. of normal. When operating their plants at normal, the factories have to export from 65 to 70 per cent. of their annual output, as their home market cannot absorb the total production. The Italian output is largely directed towards the production of luxury-cars; but both during and since the war a development has taken place in the manufacture of large transport vehicles. The exports and imports of motor cars out of and into Italy are as follows:—

	Exports.		Imports.	
Year.	Number.	Value in thousands of lire.	Number.	Value in thousands of lire.
1912	7,266	38,616	2,232	11,521
1913	6,575	34,163	2,452	14,630
1919	2,547	43,577	287	4,815
1920	11,320	307,344	1,555	43,145
1821	5,759	171,194	188	4,592

(1st half-year.)

The motor industry, with a production capacity of 33,600 cars per annum, exported 9586 cars during the first nine months of 1921 as compared with 7977 cars exported for the same period of the previous year.

A considerable demand for motor vehicles is, however, expected to assert itself in the Trieste district, where import restrictions, formerly militating against foreign imports, have now been relaxed. The new Italian Government is now considering an application made by the Ford Company, of America, to erect a motor car works in the Trieste zone for the purpose of supplying the Balkan and Eastern Mediterranean markets. At the time that the application was made the zone was duty-free, but this privilege has now been withdrawn. The proposal was warmly received by the inhabitants of Trieste, but apart from the fact that the proposals may be modified now that the zone is no longer duty-free, the Italian automobile manufacturers have urged the Government to refuse permission to the Ford Company in consequence of the poor condition of the home industry.

The output of motor lorries has increased. Those at present on the road exceed 22,000 in number. Trailers are seldom used except in the manufacturing centres, such as Milan, Turin, &c., and in certain of the port cities. Passenger cars number 28,000 and motor cycles 31,000. There are 3600 motor omnibuses and taxis in use.

The International Electrotechnical Commission.

As stated in our issue of December 1st, meetings of the International Electrotechnical Commission's advisory committees on rating, graphical symbols, standard pressures, and regulations for overhead transmission, and screw lamp caps and holders were held in Geneva from the 20th to the 26th of last month. Mr. E. Huber, president of the Swiss Committee, welcomed the delegates from the various nations on behalf of his colleagues. In addition to sixty delegates from twelve nations, Dr. Mailloux, the president, and Colonel R. E. Crompton, the honorary secretary of the Commission, were present.

It was not until Thursday, November 23rd, that, with the help of M. Boucherot, a generally acceptable proposal embodying the wishes of the British delegates was agreed to for submission to the national committees, to the effect that overload ratings within the International Electrotechnical Commission maximum continuous rating be recognised, and that, for general industrial machines, where overloads have to be provided, a machine having a 40 deg. Cent. temperature rise and capable of carrying 25 per cent. overload for two hours applied at the end of the full load run be recommended, the overload only to be applied under such conditions of air temperature as will not cause the limits of maximum temperature laid down by the International Electrotechnical Commission to be exceeded. It will be remembered that the main object of the international rating of electrical machinery is to establish an equitable basis of comparison of tenders, and much discussion took place as to the method of indicating the relation between the proposed British nominal rating and the International Electrotechnical Commission single rating. To carry this into effect Signor Semenza suggested, and it was ultimately agreed to recommend, that the rating plate of the machine indicate in addition to the other information, the output under the ordinary International Electrotechnical Commission continuous rating (50 deg. Cent. rise). With this decision the meetings of the advisory committee were adjourned, and the British delegates expressed their thanks and appreciation of the manner in which their proposals had been received.

A meeting of the advisory committee on graphical symbols was held, with Dr. Wyssling (Switzerland) in the chair. The proposals put forward at Brussels in 1920 were carefully looked through and additional symbols were added.

A meeting devoted to standard pressures and regulations for overhead transmission was also held, and in this case Dr. Mailloux took the chair. The detailed work associated with overhead transmission was not sufficiently advanced for more than a general exchange of views; but it was agreed to ask the Belgian Committee, which had taken a most prominent part in the question of regulations for overhead transmission, to bring forward for consideration a skeleton set of rules which might be adopted as a guide for all countries.

A meeting of the advisory committee on screw lamps, caps and holders was also held and was presided over by Dr. Mailloux. This is the first occasion on which the manufacturers of lamp holders in the different nations have come together under the same roof. The ground had been fully prepared by M. Zetter (Paris) and Mr. S. W. Attwell (Great Britain) and also by the Americans, and as a result of an exhaustive review of the situation the proposal of Mr. Doano (United States) that the lamp holder should first be standardised rather than the lamp cap was agreed to, and proposals in full detail are to be drawn up in consultation with the experts in the various works manufacturing the lamp holders and to be put forward at an early date.

Corrosion as Affecting the Metals Used in the Mechanical Arts.

By Dr. W. H. HATFIELD (the Brown-Firth Research Laboratories).*

IT is intended, in this paper, to put before the members of the Association the results, amongst other data, of an interesting set of experiments which were put in hand to decide upon the relative resistance to various corroding media, of typical industrial metals. The success of the metallurgist, for instance, in producing steels which are far more resistant than those formerly available is well known to you, but there are very interesting anomalies, the study of which is sure to lead to still further advances. It was established a few decades ago that the addition of a high percentage of nickel, say, 30 per cent., rendered a steel relatively rust-resisting. The work of Brearley at the Brown-Firth Research Laboratories before the war established that the addition of 12 to 14 per cent. of chromium also produced a steel which has shown great possibilities in this direction, whilst the production of a 14 to 15 per cent. silicon alloy has provided an interesting ferrous alloy which is exceptionally acid-resisting, although, unlike the high nickel and 14 per cent. chromium steels, of very indifferent mechanical properties.

Research for a truly rust-resisting steel was patiently conducted for a number of generations by careful investigators, and the means usually employed consisted of acid tests of one kind or another; but, unfortunately, the attack, for instance, of the mineral acids is no direct indication of the usefulness of an alloy for general corrosion-resisting purposes.

A 30 per cent. nickel steel is very resistant to sulphuric and hydrochloric acids, but is rapidly soluble in nitric acid, 1.20 s.g. The 14 per cent. chromium steel is readily soluble in hydrochloric and sulphuric acid, but insoluble in nitric acid, whilst the 15 per cent. silicon steel, although practically insoluble in all three acids, cannot be considered completely rustless.

These outstanding facts were largely the cause of the investigation, which the author is about to describe, being put in hand in the Brown-Firth Research Laboratories, and it has been a matter of great interest to the investigators in that institution, carefully to study the response which these various alloys have made, not only to the acids before mentioned, but to a large number of corroding media selected largely as representing, not only their own specific case, but as typifying a larger number of media.

In Table I. will be found the analyses of the various materials which formed the subject of experiment, and it will be found that, in addition to the pure irons, carbon steels, alloy steels, cast iron, 30 per cent. nickel and 14 per cent. chromium steels, nichrome, and a good selection of non-ferrous metals, together with brass and the bronzes, are included.

In Micrographs 1 to 20 are shown the microstructures of these various alloys, and it will be found that they divide themselves into two series or types, namely :—

(1) Homogeneous, consisting of one metal or solid solution.

(2) Heterogeneous, consisting of two or more constituents.

In the homogeneous category, one can place the electrolytic iron, armco iron, and probably the wrought iron specimens in this instance, manganese steel, 30 per cent. nickel steel, monel metal, aluminium, phosphor-bronze, manganese bronze, aluminium bronze, and tin bronze. These materials are homogeneous in so far as they are supposed to consist of a single phase, although the composition of a solid solution crystal is frequently non-uniform. Unfortunately, in such cases as the electrolytic iron, wrought iron, monel metal and aluminium, the impurities constitute a second constituent of no inconsiderable importance.

The remainder of the alloys dealt with are obviously heterogeneous in structure, and consist of two constituents which most likely exhibit a difference in potential and, therefore, judging the alloys from the electrolytic theory of corrosion, it would follow that the effective corrosion-resisting alloys would be found in the first category, *i.e.*, homogeneous, and that there was little to hope from the heterogeneous alloys.

The results of experiment, however, make it quite clear that apart from the 30 per cent. nickel steel and monel metal, which might be looked upon as consisting of one phase, the whole of the homogeneous alloys are readily attacked by many reagents, whereas it is amongst the heterogeneous alloys where the most likely fields for further investigation will be found. For instance, the high silicon alloy, nichrome and stainless steel are all heterogeneous alloys and hence are of great interest, not only from the practical, but from the scientific points of view.

Before proceeding with a further description of the corrosion experiments, it is perhaps useful to give the typical mechanical properties of these various alloys, and these will be found in Table II.

ACID TESTS.

To study the influence of one acid upon a particular metal is subject matter for a somewhat lengthy investigation, as has been shown by the investigation of Friend and Dennett (Chemical Society, 121.41.1922), who studied the influence of temperature, concentration, and motion on the solubility of iron in sulphuric acid. Other investigators, mostly on the Continent, have done similar work on other metals. It was, therefore, decided that in the present investigation somewhat empirical conditions of test should be laid down, and these were as follows :—

Cylindrical samples of the metals weighing about 50 grammes were machined and polished down to OO emery. They were weighed and then separately placed in vessels containing the acid at an initial temperature of 15 deg. Cent. Clearly, where excessive chemical action took place, the temperature was in some cases considerably raised during the period of duration of the test, which was twenty-four hours. After the test, the samples were taken out, washed and dried, and again weighed. The difference in weight as a result of the immersion in acid is recorded for the whole of the samples in Table III. This figure is given as the loss in weight worked out in terms of grammes per square centimetre of surface. It will be seen that the acid in each case was experimented with in two strengths, *i.e.*, (*a*) normal † ; (*b*) the strength in which it is usually employed.

The marked difference in the relative response of the various alloys to the different acids of different concentration, clearly shows that there is room for very much more investigation in this particular field. However, the results clearly bring out, on broad lines, the nature of the effect of the addition of the various elements. Perhaps three of the most interesting series of results are those related to the electrolytic iron, the armco iron and the wrought iron. The author would suggest that the explana-

TABLE I.—*Analyses.*

No.	Mark.	Material.	Carbon.	Manganese.	Silicon.	Sulphur.	Phosphorus.	Nickel.	Chromium.	Copper.	Aluminium.	Tin.	Zinc.	Lead.	Vanadium.	Iron.	Magnesium.
1	FG	Electrolytic iron (forged)	.025	nil	.04	.009	.004	—	—	—	—	—	—	—	—	—	—
2	FH	Armco	.06	.01	nil	.029	.007	.17	—	.043	.008	—	—	—	—	—	—
3	FN	Wrought iron	.03	.145	.07	.01	.193	.11	—	.059	—	—	—	—	—	—	—
4	FF	.3 carbon steel	.39	.665	.19	.024	.044	.41	—	—	—	—	—	—	—	—	—
5	FS	.9 carbon steel	.92	.615	.20	.040	.042	.27	nil	—	—	—	—	—	—	—	—
6	FY	Manganese steel	1.15	11.75	.13	.022	.056	.26	nil	—	—	—	—	—	—	—	—
7	FR	Cast iron.. Gr.	2.52														
		C.C.	.78	.58	2.25	.133	.756	—	—	—	—	—	—	—	.116	—	—
8	FT	3.0 per cent. nickel steel	.39	.65	.18	.023	.034	3.04	0.14	—	—	—	—	—	—	—	—
9	FU	3.0 per cent. nickel-chromium steel	.30	.515	.11	.017	.02	3.48	0.50	—	—	—	—	—	—	—	—
10	FJ	30.0 per cent. nickel steel	.24	1.16	.29	.014	.017	28.16	nil	—	—	—	—	—	—	—	—
11	FD	Stainless F.G.	.32	.22	.19	.018	.018	.48	13.27	—	—	—	—	—	—	—	—
12	FI	Nichrome	.28	3.16	.207	.047	.013	65.54	10.16	—	—	—	—	—	—	20.7	—
13	FA	High silicon (tantiron) C.C.	.03	.21	14.30	.045	.731	nil	—	—	—	—	—	—	—	—	—
		Gr.	.76														
14	FB	Monel metal	—	—	.20	—	—	67.58	—	28.27	nil	nil	nil	nil	—	1.57	—
15	FV	Aluminium	.08	.002	.056	nil	.026	nil	—	nil	99.64	—	nil	—	—	.139	.055
16	FQ	Duralumin	trace	.55	.24	—	—	—	—	3.97	94.00	—	nil	—	—	.34	.81
17	FW	Brass	—	—	—	—	—	—	—	56.54	—	0.12	40.02	2.82	—	0.28	—
18	FK	Phosphor bronze	—	nil	—	—	—	—	—	90.37	nil	3.42	nil	.01	—	.084	—
19	FL	Manganese bronze	—	3.49	—	—	—	nil	nil	95.90	nil	.13	—	—	—	.39	—
20	FM	Aluminium bronze	—	—	—	—	—	nil	—	92.03	8.03	nil	nil	nil	—	nil	—
21	FX	Tin bronze	—	—	—	—	.15	—	—	94.44	—	4.94	trace	nil	—	0.22	—

TABLE II.—*Mechanical Properties.*

No.	Mark.	Material.	Condition.	Brinell hardness number.	Tensile. Elastic limit.	Yield point.	Maximum stress.	Elongation, per cent.	Reduction of area, per cent.	Izod, foot-pounds.	Fatigue range, ± 10,000,000 revolutions.
1	FG	Electrolytic iron (forged)	Normalised	90	—	12.4	18.6	34.0	63.1	—	
2	FH	Armco iron	Normalised	97	—	14.3	22.4	28.0	65.0	20	
3	FN	Wrought iron	As forged	112	12.1	14.5	23.4	31.0	48.0	44	11.7
4	FF	.3 per cent. carbon steel	Normalised	167	20.8	21.5	37.4	28.0	52.0	31	13.8
5	FS	.9 per cent. carbon steel	Normalised	286	23.16	32.4	59.4	11.0	15.5	2	16.5
6	FY	Manganese steel	Water quenched	200	—	—	65.0	50.7	—	—	
7	FR	Cast iron	As cast	—	—	—	10.6	0.20	Nil	1	
8	FT	3.0 per cent. nickel steel	O.Q. 850° C.; tempered 600° C.	217	30.8	41.7	49.51	24.0	63.6	72	21.5
9	FU	3.0 per cent. nickel-chromium steel	O.Q. 850° C.; tempered 600° C.	269	47.0	56.0	62.0	21.0	62.0	49	28.0
10	FJ	30.0 per cent. nickel steel	Forged	—	—	22.1	41.3	30.0	50.2	—	
11	FD	Stainless F.G.	O.Q. 975° C.; tempered 700° C.	275	33.8	44.6	58.9	21.5	53.0	20	22.0
12	FI	Nichrome	Forged	195	13.0	33.3	47.7	26.0	40.5	—	
13	FA	High silicon (tantiron)	As cast	—			Extremely brittle				
14	FB	Monel metal	Forged	167	—	20.1	39.8	47.0	67.0	—	11.1
15	FV	Aluminium	Cold worked	26	0.68	2.17	4.94	41.0	77.0	—	
16	FQ	Duralumin	—	115	14.1	21.4	29.9	16.0	21.0	18	9.0
17	FW	Brass	Cold rolled	124	15.0	21.3	24.5	34.0	58.6	33	13.0
18	FK	Phosphor bronze	Cold rolled	120	15.9	25.6	26.3	27.0	73.2		
19	FL	Manganese bronze	Cold rolled	106	16.1	23.2	23.8	23.0	66.8		
20	FM	Aluminium bronze	Cold rolled	119	—	10.1	29.1	70.0	71.7		
21	FX	Tin bronze	Cold rolled								

TABLE III.—*Standard Acid Tests.*

No.	Mark.	Material.	Hydrochloric acid. Normal.	Hydrochloric acid. Concentrated.	Nitric acid. Normal.	Nitric acid. 1.20 S.G.	Sulphuric acid. Normal.	Sulphuric acid. 10 per cent.
1	FG	Electrolytic iron (forged)	.0085	.0860	.1147	.7261	.0057	.0068
2	FH	Armco iron	.0116	.1385	.1406	.7592	.0979	.0152
3	FN	Wrought iron	.1416	.2217	.1263	.6399	.1452	.3610
4	FF	.3 per cent. carbon steel	.0850	.1812	.1154	.5858	.1052	.1032
5	FS	.9 per cent. carbon steel	.0584	.1802	.1180	.4923	.0453	.1076
6	FY	Manganese steel	.0059	.2346	.1287	.5427	.1682	.3843
7	FR	Cast iron	.1340	.3280	.1022	.1300	.1364	.1158
8	FT	3.0 per cent. nickel steel	.0254	.2031	.1168	.6405	.0331	.0725
9	FU	3.0 per cent. nickel-chromium steel	.0160	.2094	.0101	.0188	.0128	.0434
10	FJ	30.0 per cent. nickel steel	.0017	.0405	.1333	.7672	.0006	.0004
11	FD	Stainless F.G.	.0638	.1799	.0111	Nil	.0871	.1126
12	FI	Nichrome	.0016	.0520	.0147	.0004	.0006	.0006
13	FA	High silicon (tantiron)	.0007	.0009	.0003	.0008	.0010	.0006
14	FB	Monel metal	.0004	.0062	.0009	.1933	.0003	.0001
15	FV	Aluminium	.0268	.0841	.0004	.0009	.0002	.0002
16	FQ	Duralumin	.0656	.4359	.0027	.0025	.0006	.0004
17	FW	Brass	.0003	.0165	.1588	.8011	.0004	.0003
18	FK	Phosphor bronze	.0008	.0017	.0044	.7160	.0004	.0002
19	FL	Manganese bronze	.0008	.0021	.0079	.6051	.0004	.0003
20	FM	Aluminium bronze	.0004	.0023	.0023	.5690	.0003	.0002
21	FX	Tin bronze	.0007	.0023	.0031	.7058	.0004	.0004

Period of standard acid tests 24 hours, 15 deg. Cent. initial temp.

* Sheffield Association of Metallurgists and Metallurgical Chemists, December 5th, 1922.

† Normal means an acid containing one gramme of available hydrogen per litre.

tion of the order in which these are placed in relative solubility is somewhat difficult to explain. The electrolytic iron certainly contains a lot of oxide of iron resulting from the forging operation, which one would have expected to facilitate the attack, but it is clear the extreme purity of this material has more than counterbalanced this effect, or possibly the composition of the slag may be the determining feature. The armco material is very pure, although there is a higher sulphur and carbon content than in the exposure of these various alloys under the following conditions :—

(1) Totally immersed in running water (for thirty days) ;

(2) alternately wet and dry (for thirty days) ; together with

(3) the effect of steam at 100 deg. Cent. in the presence of oxygen for a week.

In speaking of "wet and dry," which involves the exposure, totally immersed in sea water, vinegar, and 33 per cent. acetic acid.

In Table VI. will be found the effects on these materials in 5 per cent. citric acid, 5 per cent. ammonium chloride solution, and 1 per cent. magnesium chloride.

In Table VII. is shown the influence of 10 per cent. sodium sulphate solution, 5 per cent. magnesium sulphate solution, and 33 per cent. sodium hydroxide.

In Table VIII. the whole of these results are summarised

TABLE IV.—*Corrosion Tests.*

No.	Mark	Material.	Running water.	Wet and dry test.	Steam 100° C. in presence of oxygen.
1	FG	Electrolytic iron (forged) ..	General corrosion .0129	Corroded .0015	Slight corrosion .0001
2	FH	Armco iron	General corrosion .0126	Corroded .005	Slight corrosion .0002
3	FN	Wrought iron	General corrosion .0161	Corroded .0058	Slight corrosion .0001
4	FF	.3% carbon steel	General corrosion .0150	Corroded .0085	Slight corrosion .0002
5	FS	.9% carbon steel	General corrosion .0224	Corroded* .0014	Corroded .0001
6	FY	Manganese steel	General corrosion .0222	General corrosion .0064	Corroded .0006
7	FR	Cast iron	Corroded .0226	Corroded* .0002	Corroded .0002
8	FT	3.0% nickel steel	General corrosion .0146	General corrosion .0004	Slight corrosion .0002
9	FU	3.0% nickel-chromium steel	General corrosion .0135	General corrosion .0005	Slight corrosion .0003
10	FJ	30.0% nickel steel	Unaffected, except one pit	Unaffected, except contact	Slight corrosion .0003
11	FD	Stainless F.G.	Unaffected	Unaffected .0002	Very faint local attack .0001
12	FI	Nichrome	Unaffected	Unaffected, except contact .0001	Unaffected .0001
13	FA	High silicon (tantiron) ..	Very slight .0002	Very very slight	Slightly coloured .0001
14	FB	Monel metal	Unaffected	Very slight corrosion .0001	Slightly coloured .0001
15	FV	Aluminium	Local stains	Very slightly stained	Film of alumina
16	FQ	Duralumin	Local pitting .0018	Stained .0001	Slight oxidation .0002
17	FW	Brass	Surface oxidised	Slightly stained	Oxidation of surface .0002
18	FK	Phosphor bronze	Surface oxidised .0003	Surface oxidised .0001	Surface oxidised .0001
19	FL	Manganese bronze	Surface oxidised .0004	Surface oxidised .0001	Surface oxidised .0001
20	FM	Aluminium bronze	Faint staining	Faint staining	Surface oxidised .0002
21	FX	Tin bronze	Surface oxidised	Slight staining	Surface oxidised .0002

Period of corrosion tests one month—15° C.
Corrosion products removed as far as possible before weighing (* corrosion product adheres).

TABLE V.—*Corrosion Tests.*

No.	Mark	Material.	Salt water (sea).	Vinegar.	33% Acetic acid (B P.).
1	FG	Electrolytic iron (forged) ..	Corroded .0037	Stained .0044	Slightly attacked .0092
2	FH	Armco iron	Corroded .0042	Stained .0038	Slightly attacked .0096
3	FN	Wrought iron	Corroded .0036	Stained .01	Attacked .2023
4	FF	.3% carbon steel	Corroded .0047	Stained .0032	Attacked .1492
5	FS	.9% carbon steel	Corroded .0039	Stained .003	Attacked .1245
6	FY	Manganese steel	Corroded .0041	Corroded .0286	Attacked .0719
7	FR	Cast iron	Corroded .004	Badly attacked .1901	Attacked .4819
8	FT	3.0% nickel steel	Corroded .0048	Stained .0036	Attacked .0609
9	FU	3.0% nickel-chromium steel	Corroded .0045	Stained .0044	Attacked .0551
10	FJ	30.0% nickel steel	Unaffected, except contact	Stained .0020	Slightly attacked .0059
11	FD	Stainless F.G.	Unaffected except contact	Unaffected	Attacked .0232
12	FI	Nichrome	Unaffected, except contact .0002	Surface dulled .0031	Slightly attacked .0058
13	FA	High silicon (tantiron) ..	Very slight .0005	Very slight stain .0004	Very slight attack .0003
14	FB	Monel metal	Unaffected, except contact .0002	Very slightly stained .0019	Slightly attacked .0031
15	FV	Aluminium	Faintly stained	Surface etched .0006	Extremely slight attack .0006
16	FQ	Duralumin	Stained and local pitting .0002	Slightly stained .0008	Very slight attack .0018
17	FW	Brass	Slight attack	Slightly stained	Slightly attacked .0055
18	FK	Phosphor bronze	Slight attack .0011	Slightly stained .0005	Slight attack .0045
19	FL	Manganese bronze	Slight attack .0012	Slightly stained .0005	Slight attack .0050
20	FM	Aluminium bronze	Slight attack .0006	Very slightly stained .0002	Slight attack .0043
21	FX	Tin bronze	Slight attack	Slight staining	Slightly attacked .0067

Period of corrosion tests one month—15° C.
Corrosion products removed as far as possible before weighing.

TABLE VI.—*Corrosion Tests.*

No.	Mark	Material.	5% citric acid.	5% ammonium chloride.	1% magnesium chloride.
1	FG	Electrolytic iron (forged) ..	Attacked .0076	Corroded .0106	General corrosion .0036
2	FH	Armco iron	Attacked .0117	Corroded .0103	General corrosion .0036
3	FN	Wrought iron	Attacked .1075	Corroded .0084	General corrosion .0033
4	FF	.3% carbon steel	Attacked .1458	Corroded .0124	General corrosion .0036
5	FS	.9% carbon steel	Attacked .1327	Corroded .0104	General corrosion .0035
6	FY	Manganese steel	Attacked .0695	Corroded .0196	General corrosion .0040
7	FR	Cast iron	Attacked .1404	Corroded .0101	General corrosion .0032
8	FT	3.0% nickel steel	Attacked .0289	Corroded .0123	General corrosion .0034
9	FU	3.0% nickel-chromium steel	Attacked .0283	Corroded .0138	General corrosion .0030
10	FJ	30.0% nickel steel	Slight attack .0026	Corroded .0043	Corroded where in contact, with slight general staining .0008
11	FD	Stainless F.G.	Attacked .0422	Slightly corroded .0014	Corroded where in contact, with several very small local pits .0018
12	FI	Nichrome	Slight attack .0021	Unaffected	Unaffected, except where supported .0002
13	FA	High silicon (tantiron) ..	Slight attack .0012	Slight corrosion .0003	Very slight corrosion .0004
14	FB	Monel metal	Slight attack .0021	Attacked .0103	Unaffected, except where supported .0001
15	FV	Aluminium	Almost unaffected .0001	Slight corrosion .0012	Slightly stained .0002
16	FQ	Duralumin	Very slight attack .0001	Slight corrosion .0012	Slightly stained .0002
17	FW	Brass	Slight attack .0037	Slight attack .0049	Very slight staining .0007
18	FK	Phosphor bronze	Slight attack .0028	Attacked .0305	Slight general staining .0004
19	FL	Manganese bronze	Slight attack .0029	Attacked .0310	Slight general staining .0004
20	FM	Aluminium bronze	Slight attack .0026	Local pitting .003	Slight general staining .0001
21	FX	Tin bronze	Slight attack .003	Attacked .0258	Slight general staining .0005

Period of corrosion tests one month—15° C.
Corrosion products removed as far as possible before weighing.

TABLE VII.—*Corrosion Tests.*

No.	Mark	Material.	10% Na_2SO_4	5% $MgSO_4$	33% NaHO.
1	FG	Electrolytic iron (forged) ..	General corrosion .0028	General corrosion .0033	Unaffected
2	FH	Armco iron	General corrosion .0027	General corrosion .0037	Unaffected
3	FN	Wrought iron	General corrosion .0025	General corrosion .0029	Very slight corrosion
4	FF	.3% carbon steel	General corrosion .0029	General corrosion .0038	Darkened surface .0001
5	FS	.9% carbon steel	General corrosion .0031	General corrosion .0035	Surface slightly darkened .0001
6	FY	Manganese steel	General corrosion .0027	General corrosion .0039	Unaffected, except where supported .0001
7	FR	Cast iron	General corrosion .0022	General corrosion .0029	Unaffected
8	FT	3.0% nickel steel	General corrosion .0022	General corrosion .0030	Surface darkened
9	FU	3.0% nickel-chromium steel	General corrosion .0030	General corrosion .0031	Unaffected
10	FJ	30.0% nickel steel	Slight corrosion .0011	General staining, with corrosion where supported .0011	Unaffected
11	FD	Stainless F.G.	Unaffected	Unaffected, except where supported .0013	Unaffected
12	FI	Nichrome	Unaffected	Unaffected, except where supported .0003	Unaffected
13	FA	High silicon (tantiron) ..	Slight corrosion .0004	Very slight corrosion .0003	Very slight corrosion .0015
14	FB	Monel metal	Unaffected	Unaffected, except where supported .0001	Unaffected
15	FV	Aluminium	Slightly stained	Very faintly stained .0001	Completely dissolved .7132
16	FQ	Duralumin	Unaffected	Very slightly stained .0001	Completely dissolved .7393
17	FW	Brass	Stained .0001	Very faintly stained .0002	Unaffected
18	FK	Phosphor bronze	Unaffected	Very faintly stained .0001	Stained .0001
19	FL	Manganese bronze	Stained locally	Slightly stained nil	Stained .0001
20	FM	Aluminium bronze	Faint staining .0001	Slightly stained .0002	Faint local staining
21	FX	Tin bronze	Unaffected	Very slightly stained .0002	Local staining

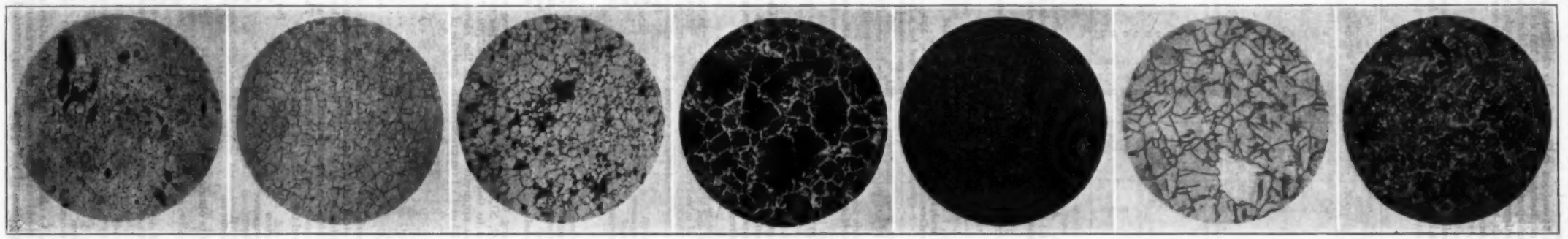
Period of corrosion tests one month—15° C.
Corrosion products removed as far as possible before weighing.

case of the electrolytic iron. The explanation of the attack upon the wrought iron is, in the author's opinion, due to the higher manganese and phosphorus and also the slag content. If the 3 per cent. nickel and the 3 per cent. nickel-chromium steels are studied, it would be found that the small percentage of chromium has had a remarkable influence upon the resistance to nitric acid. (Compare the effective influence of 14 per cent.) However, the figures must be left in this table for the careful consideration of members.

In Table IV. will be found the results from a month's atmosphere, it might be pointed out that the atmosphere in industrial towns by no means consists purely of oxygen and nitrogen. Apart from small percentages of other elements normally present, there is usually quite an active percentage of oxides of sulphur. Our own atmosphere in the neighbourhood of the laboratories gave in a typical test :—SO_3 so low as to be quantitatively indeterminable ; SO_2, .000035 grammes per litre. This clearly shows a distinct acidity due to the combustion of fuel and the conduct of chemical manufacturing in the district.

In Table V. will be found the results of a thirty days' and the table contains a technical, as distinct from a scientific statement, of the empirical results of the experiments. In the earlier tables detailed descriptions and weights are given. The changes in weight, for obvious reasons, are only of any value when the reaction of the corroding media with the specimen is carefully studied, and this will be fully appreciated by other investigators. The descriptive results are necessarily at times somewhat inconclusive, and the author has, therefore, in Table VIII. stated broadly for the interest of the industrial community the empirical results of the experiments. It will be seen

CORROSION TESTS—MICROGRAPHS OF SAMPLES TESTED



1. **ELECTROLYTIC IRON (FORGED)** × 67.
Etched 2% HNO_3.

2. **ARMCO IRON** × 67.
Etched 2% HNO_3.

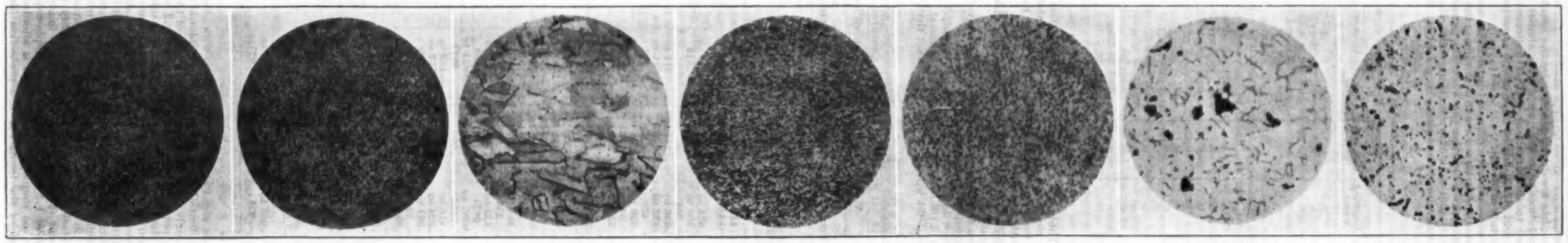
3. **WROUGHT IRON** × 67.
Etched 2% HNO_3.

4. **0.39% C. STEEL** × 67.
Etched 2% HNO_3.

5. **0.90% C. STEEL** × 67.
Etched Picric Acid.

6. **MANGANESE STEEL** × 335.
Etched Picric Acid.

7. **GREY CAST IRON** × 67.
Etched 2% HNO_3.



8. **3% NICKEL STEEL** × 67.
Etched Picric Acid.

9. **3% NICKEL CHROME STEEL** × 67.
Etched Picric Acid

10. **30% NICKEL STEEL** × 335.
Etched $FeCl_3$ + HCl.

11. **STAINLESS F.G.** × 335.
Etched $FeCl_3$ + HCl.

12. **NICHROME** × 335.
Etched 5% HNO_3.

13. **TANTIRON** × 67.
Unetched.

14. **MONEL METAL** × 168.
Etched 50% HNO_3 + 25% Ac.

15. **ALUMINIUM** × 168.
Etched 10% HF (in water).

16. **DURALUMIN** × 168.
Etched 50% KOH (in water).

17. **BRASS** × 200.
Etched 20% Amm. Persulph.

18. **PHOSPHOR BRONZE** × 168.
Etched 20% Amm. Persulph.

19. **MANGANESE BRONZE** × 168.
Etched $FeCl_3$ + HCl.

20. **ALUMINIUM BRONZE** × 168.
Etched 20% Amm. Persulph.

21. **TIN BRONZE** × 168.
Etched 20% Amm. Persulph.

that no steel, metal, or alloy experimented upon resists all the media. It will be found that one media (acetic acid) is resisted by none of the specimens. The nichrome has the best record. The 14 per cent. chromium steel may perhaps be placed next. Aluminium, monel metal and tantiron give excellent results, whilst 30 per cent. nickel steel is well up the list. With extension of the experiments to other media the order would probably be modified, but the experiments here described were arranged to deal with those in which the author considered the industrial world to be most interested.

It is of interest, in considering the response of these various industrial alloys to the acid tests to study the effect of the acids on pure metals. The purest metals available were submitted to 1.20 nitric, 10 per cent. sulphuric, and concentrated hydrochloric, with the results shown in Table II.

A careful study of the foregoing data leads the author to two conclusions :—

(1) That there are now available steels and alloys effective in resisting ordinary corroding influences. These different alloys, whilst at times each resisting the same media, do not give the same response to other media. That it is essential in the application of corrosion and acid-resisting alloys that actual practical experiments be made in connection with the particular application which is intended, since not only composition, but also concentration, temperature, and extraneous influences must be considered.

(2) There is no obvious law, or set of laws, at present available, nor is any existing working theory sufficiently satisfactory, to render effective aid to the investigator who is working in these fields. The author and his assistants have, with the greatest interest, followed the various modifications of theory which have been advanced of late. They feel that there is much in the interesting colloidal hypothesis put forward by Dr. Friend, and they also feel that Dr. Bengough has done extremely valuable work, not only in extending Dr. Friend's theory, but also in the excellent experimental criticism to which he has submitted the various other theories which have been enunciated from time to time.

We have ourselves given no little attention to theoretical matters, and we are driven perforce by the results of our various experiments to take up a very similar position with regard to these matters as that indicated by Dr. Bengough and Mr. Stuart in their recent corrosion report to the Institute of Metals.

For instance, we have done a considerable amount of experimental work with a view to determining the relation which might exist between the electrode potential (see Appendix I) and solubility, it being understood that solubility was a function of electrode potential. The data shown in Table IX. will enable other investigators to compare the electrode potentials with the solubility and corrosion results recorded in Table III. Our main conclusions with regard to this work are :—

(1) When rapid solution takes place the potential is highly negative.

(2) When the potential has a high positive value, very little corrosion or chemical action takes place.

(3) Otherwise the magnitude of the potential gives no indication of the solution properties of the metal.

Another point worthy of note is the fact that, in those cases where rapid corrosion takes place with evolution of gas, the potentials in hydrochloric and sulphuric acids are approximately the same, whilst in the case of the normal acids the potential in nitric acid is about .2 volts less negative than in the other two acids. No satisfactory explanation of these observations can be put forward. The difference in the liquid junction potentials and in the H ion concentration is insufficient to account for them.

It further appears that the history of the metal has some influence on the measured electrode potential. This is shown in Table X., which gives the potentials of the stainless steel in strong acids (*a*) with freshly prepared surface, and (*b*) after twenty-four hours' immersion in nitric acid of 1.2 specific gravity. A simple explanation (probably too simple) of these results is afforded by the supposition of the formation of a protective film, as in Dr. Bengough's theory of corrosion, which film is slowly soluble in hydrochloric acid, and still more slowly soluble in sulphuric acid.

Efforts have been made by us to study the potentials of the constituents of these alloys, but the difficulties are almost insuperable. However, since the electrolytic method is frequently used by metallurgists for preparing carbides, it will be interesting to put on record figures obtained in our experiments in that direction.

CARBIDES IN STAINLESS STEELS.

The method of obtaining the carbides was similar to that used by Arnold and Read, and later by Arnold and Ibbotson. A bar of stainless steel (tempered from 750 deg. Cent.) about 1 cm. in diameter was made the anode of an electrolytic cell, containing hydrochloric acid (specific gravity 1.02) as the electrolyte. The cathode of platinum foil was enclosed in a porous jar. A current of 1.8 ampères derived from a 2-volt cell was used. The following results were obtained :—

Difference in weight of stainless bar before and after the experiment	=	50.0510 grams.
Weight of mixed carbides obtained	=	2.7400 grams.

Analysis of Steel Used.

	Per cent.
Carbon	0.37
Manganese	0.22
Nickel	0.25
Chromium	13.96

Analysis of Carbides.

Carbon	5.44
Manganese	0.92
Chromium	52.20
Iron	40.70
Nickel	0.86

Assuming the iron, nickel and manganese are in the form Fe_3C, Ni_3C, and Mn_3C respectively, the ratio of the chromium to the remaining carbon is 52.20 : 2.78, from which the apparent composition of the chrome carbide is 1 : 0.232 or 4 : 1 (approx.). The analysis of the carbides is then :—

	Per cent.
Fe_3C	43.60
Mn_3C	0.99
Ni_3C	0.91
Cr_4C	54.98

The experiment was repeated with another sample of stainless steel and the resulting carbides compared with the residue obtained after direct immersion in hydrochloric acid of the same concentration. The steel was immersed in each case for a period of twenty hours. The analysis of the steel used in this case was :—

	Per cent.
Carbon	0.30
Manganese	0.31
Silicon	0.31
Nickel	0.29
Chromium	14.58

The results obtained were as follows :—

	With current (1.5 amps. 2 volts.)	Without current.
Weight of steel removed	21.5 grams.	6.3 grams.
Weight of carbides obtained	0.85 grams.	0.185 grams.

Analysis of Carbides.

	With current.	Without current.
Carbon	5.20	5.10
Chromium	51.30	68.40
Iron, manganese, nickel	43.50	26.50

It is to be observed that the rate of solution of the steel is more rapid with the current than without, and that the composition of the carbon residue obtained by direct

TABLE VIII.

No.	Mark	Material.	Hydrochloric acid.	Nitric acid.	Sulphuric acid.	Running water.	Wet and dry.	Sea water.	Vinegar.	33% acetic acid.	5% citric acid.	5% ammonium chloride.	1% magnesium chloride.	10% sodium sulphate.	5% magnesium sulphate.	33% sodium chloride.
1	FG	Electrolytic iron (forged)	×	×	×	×	×	×	×	×	×	×	×	×	×	o
2	FH	Armco iron	×	×	×	×	×	×	×	×	×	×	×	×	×	o
3	FN	Wrought iron	×	×	×	×	×	×	×	×	×	×	×	×	×	×
4	FF	.3% carbon steel	×	×	×	×	×	×	×	×	×	×	×	×	×	×
5	FS	.9% carbon steel	×	×	×	×	×	×	×	×	×	×	×	×	×	×
6	FY	Manganese steel	×	×	×	×	×	×	×	×	×	×	×	×	×	o
7	FR	Cast iron	×	×	×	×	×	×	×	×	×	×	×	×	×	o
8	FT	3.0% nickel steel	×	×	×	×	×	×	×	×	×	×	×	×	×	×
9	FU	3.0% nickel-chromium steel	×	×	×	×	×	×	×	×	×	×	×	×	×	o
10	FJ	30.0% nickel steel	×	×	o	o	o	o	×	×	×	×	o	×	×	o
11	FD	Stainless F.G.	×	o	×	o	o	o	o	×	×	×	o	o	o	o
12	FI	Nichrome	×	o	o	o	o	o	×	×	×	o	o	o	o	o
13	FA	High silicon (tantiron)	o	o	o	o	o	o	×	×	×	×	×	o	o	×
14	FB	Monel metal	×	×	o	o	o	o	×	×	×	×	o	o	o	o
15	FV	Aluminium	×	o	o	o	o	o	×	×	o	×	×	o	o	×
16	FQ	Duralumin	×	×	o	o	o	×	×	×	×	×	×	o	o	×
17	FW	Brass	×	×	o	o	o	×	×	×	×	×	×	×	o	o
18	FK	Phosphor bronze	×	×	o	o	o	×	×	×	×	×	×	o	o	×
19	FL	Manganese bronze	×	×	o	o	o	×	×	×	×	×	×	o	o	×
20	FM	Aluminium bronze	×	×	o	o	o	×	×	×	×	×	×	o	o	×
21	FX	Tin bronze	×	×	o	o	o	×	×	×	×	×	×	o	o	×

TABLE IX.—*Electrode Potentials.*

No.	Mark.	Material.	Hydrochloric acid.		Nitric acid.		Sulphuric acid.	
			Normal.	Strong conc.	Normal.	Strong (1.20 sp. gr.)	Normal.	Strong (10 per cent.)
1	FG	Electrolytic iron (forged)	−.575 to −.590	−.547 to −.524	−.333 to −.350	−.175 to −.142	−.560 to −.571	−.559 to −.547
2	FH	Armco iron	−.570 to −.552	−.535 to −.514	−.320 to −.330	−.140 to −.129	−.501 to −.529	−.473 to −.543
3	FN	Wrought iron	−.557 to −.535	−.505 to −.489	−.382 to −.429	−.189 to −.150	−.534 to −.526	−.548 to −.530
4	FF	.3 per cent. carbon steel	−.596 to −.600	−.508 to −.500	−.411 to −.447	−.271 to −.309 to −.252	−.625 to −.618	−.531 to −.499
5	FS	.9 per cent. carbon steel	−.555 to −.515	−.501 to −.491	−.338 to −.409 to −.358	−.253 to −.003	−.548 to −.519	−.522 to −.496
6	FY	Manganese steel	−.535 to −.513	−.582 to −.537	−.336 to −.432 to −.420	−.241 to −.057	−.514 to −.524 to −.481	−.510 to −.466
7	FR	Cast iron	−.543 to −.515	−.463 to −.439	−.530 to −.340	−.238 to +.731	−.534 to −.525	−.518 to −.494
8	FT	3.0 per cent. nickel steel	−.519 to −.485	−.521 to −.502	−.330 to −.410	−.236 to −.196	−.500 to −.494	−.489 to −.484
9	FU	3.0 per cent. nickel-chromium steel	−.504 to −.509	−.517 to −.495	−.289 to −.341	−.194 to −.170	−.486 to −.492 to −.489	−.462 to −.456
10	FJ	30.0 per cent. nickel steel	−.449 to −.381	−.471 to −.402	−.161 to −.245	+.084 to +.094	−.390 to −.288	−.385 to −.324
11	FD	Stainless F.G.	−.573 to −.569	−.525 to −.514	−.2875 to −.312	+.388 to +.641	−.588 to −.571	−.516 to −.525
12	FI	Nichrome	−.375 to −.410	−.445 to −.439	−.385 to −.336	+.357 to +.496	−.331 to −.388	−.334 to −.348
13	FA	High silicon (tantiron)	−.513 to −.495	−.420 to −.448	−.439 to −.0621	+.702 to +.741	−.523 to −.468	+.631 to −.427
14	FB	Monel metal	−.271 to −.268	−.381 to −.389	+.0287 to −.0352	+.008 to .000	−.0624 to −.0373	−.108 to −.042
15	FV	Aluminium	−.856 to −.815	−1.155 to −1.121	−.418 to −.504 to −.361 to −.394	−.278 to −.194	−.452 to −.713 to −.689	−.573 to −.765
16	FQ	Duralumin	−.685 to −.643	−.918 (*circa*)	−.095 to −.330	−.190 to −.174	−.531 to −.574	−.597 to −.550
17	FW	Brass	−.435 to −.347 to −.384	−.590 to −.554	−.061 to −.174	−.010 to +.016	−.146 to −.177	−.181 to −.213
18	FK	Phosphor bronze	−.307 to −.252	−.513 to −.496	−.047 to −.050	+.089 to +.095	−.089 to −.045	−.126 to −.079
19	FL	Manganese bronze	−.296 to −.280	−1526 to −.508	−.0683 to −.0463	+.044 to +.063	−.0795 to −.104	−.223 to −.087
20	FM	Aluminium bronze	−.290 to −.313 to −.239	−.583 to −.538	−.065 to −.068	−.0095 to +.011	−.084 to −.061	−.139 to −.112
21	FX	Tin bronze	−.287 to −.258	−.537 to −.504	−.066 to −.034	+.077 to +.086	−.094 to −.027	−.094 to −.067

TABLE X.—*Single Potential Measurements of Stainless Steel in Strong Acids.*

Mark	FD
Material	Stainless, F.G.
Nitric acid, 1.20 sp. gr.	+.380 to +.655. Unaffected
Sulphuric acid, 10 per cent. solution —	
Fresh surface	−.562 to −.530. Remained unaffected for a few seconds, when gas evolved freely
After 24 hours' immersion in 1.20 S.G. nitric acid	+.591 to −.520. Remained passive for several hours, then gas evolved freely
Hydrochloric acid, cone'd.—	
Fresh surface	−.544 to −.526. Gas evolved immediately on immersion
After 24 hours' immersion in 1.20 S.G. nitric acid	−.544 to −.525. Remained unaffected for a few seconds, then gassed freely

solution contains a considerably higher percentage of chromium than that obtained by electrolysis.

That the rate of decomposition of the steel should be more rapid with the aid of an electric current is not surprising. The difference of potential applied to the electrolyte causes a migration of negative ions (chlorine ions) to the surface of the steel. It is these ions which react with the matrix of the steel, forming, in this case, soluble chlorides. Without the aid of the electric current, the number of chlorine ions in the vicinity of the steel is obviously much less, and, in consequence, the rate of corrosion must be inferior. The rate of corrosion is also diminished by the presence of hydrogen ions and of hydrogen molecules (evolved as the result of the reaction)

TABLE XI.—*Acid Tests on Pure Metals.*

Samples of the following pure metals were immersed in concentrated hydrochloric, 1.20 nitric, and 10 per cent. sulphuric acids, beginning at a temperature of 15 deg. Cent. for 24 hours. The volume of acid used was 85 cc. in all cases.

Hydrochloric Acid.

	Alteration in weight, grammes per sq. cm. of surface area.	Remarks.
Iron	−0.0814	Slight action
Nickel	−0.0037	Very slight action
Cobalt	−0.0480	Slight attack
Manganese	−1.1579	Completely dissolved
Aluminium	−0.1071	Violent initial action, afterwards little action
Copper	−0.0018	Slightly stained
Chromium	−0.2014	Slight action
Silicon	+0.0002	Very slight action. (The gain in weight is possibly due to a deposit of silica.)

1.20 *Nitric Acid.*

Iron	−0.7165	Readily soluble
Nickel	−0.1546	Slight action
Cobalt	−0.4210	Easily soluble
Manganese	−0.5688	Very readily soluble
Aluminium	−0.0010	Very faint staining
Copper	−0.5708	Readily soluble
Chromium	−0.0006	No visible effect
Silicon	−0.0002	Not visibly affected

10 *Per Cent. Sulphuric Acid.*

Iron	−0.0327	Slight action
Nickel	−0.0002	Faint staining
Cobalt	−0.0150	Very slight attack
Manganese	−0.7724	Very readily soluble
Aluminium	−0.0002	Extremely slight staining effect
Copper	−0.0002	Very faint staining
Chromium	−0.0014	Extremely slight attack
Silicon	−0.0003	No visible effect

which collect in the form of bubbles on the surface of the metal and so prove a kind of barrier to the attack of further chlorine ions.

The presence of the hydrogen ions may also account for the difference in composition of the carbides. That Fe_3C is attacked by strong hydrochloric acid is undoubted, and there seems no reason to believe that the action does not take place when diluted acid is used, although, of course, the rate of the reaction is much slower. It is probable that it is the hydrogen ions which do the damage, forming hydro-carbons by combination with the carbon, and leaving the iron in the ionic form (that is, in solution). In the case in which a current was used the hydrogen ions are moved away from the metal, and hence this action cannot take place with the result that the carbides obtained by this method have a greater proportion of Fe_3C.

It is to be noted that the analyses of the chrome carbides in the two cases work out as follows:—When current is used, Cr_3C; when no current is used, Cr_4C.

No notice should, however, be given to this variation, as owing to the small amount of carbide used for analysis, a small error in the estimation of the carbon would be sufficient to account for the difference.

The author trusts that the results which have been put before the members have been of interest. Personally, he has looked upon this work as being somewhat fundamental in the study of rust-resisting steels.

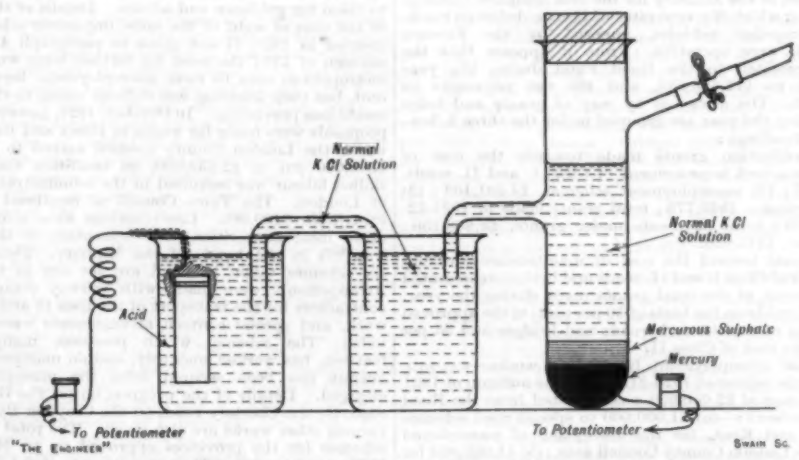
In conclusion, he wishes to record the great assistance and enthusiastic help which he has received in the experimental work from Mr. Bolsover, Mr. Stanfield, and particularly Messrs. Clements, Woolman and Barraclough, and, lastly, he desires to thank his directors for permission to place these matters freely before you.

APPENDIX.—THE MEASUREMENT OF ELECTRODE POTENTIALS.

In order to measure single electrode potentials it is necessary to couple the electrode with some standard electrode to make up a voltaic combination. The electromotive force of this combination, which is measured by some form of potentiometer, is the algebraic difference of the single potentials of the two electrodes. Therefore, that of the standard being known, the single potential of the unknown potential is easily deduced. The standard electrode used throughout these experiments is the standard normal calomel electrode. This consists of pure mercury covered with a layer of pure mercurous chloride (calomel) and immersed in a solution of potassium chloride which contains 74.6 grammes of this salt per litre (normal solution). The mercury used is washed through concentrated nitric acid and water, and is then distilled. The mercurous chloride is obtained pure and then washed several times with KCl solution. It is then ground in an agate mortar with a little pure mercury and a little potassium chloride (KCl) solution so as to form a thin paste. The absolute potential of this electrode is usually taken as + 0.5600 volts (metal positive to solution), but as there is a little doubt as to the accuracy of this value, it is customary to take its value as being zero and to refer all other potentials to this standard. Throughout the whole of this work all values of potentials are given in volts and are referred to the standard calomel electrode as zero.

For the determination of its E.P. the metal was obtained in the form of a cylinder weighing about 50 grammes. A copper wire was twisted round one end, which end was covered with paraffin wax to prevent the acid from reaching the copper. The metal was then immersed in a given acid contained in a small beaker, and connection was made with the standard electrode through another small beaker containing normal KCl solution.

The E.M.F. of the combination was measured as soon as possible after the metal was immersed in the acid, and then at periods of about ½ hour until a steady reading was reached. In many cases the change of the E.M.F. was very rapid at first, so that in these cases the initial readings are only approximate. In Tables IX. and X. are given the first and final determinations of the E.M.F. in each case and any other determination which is necessary to indicate the trend of the changes which took place.



APPARATUS FOR MEASUREMENT OF ELECTRODE POTENTIALS

Under the heading "Furnace Conditions," the author said that were it possible to provide the fuel in the state of an impalpable powder and then mix it with nearly its correct quantity of air, confine the flame in a non-conducting chamber until chemical action was complete, and then convey the products over a clean absorbing surface at such a speed that a further increase caused less additional heat to be absorbed than had to be diverted to the mechanical propulsion of the gases, the problem would be solved. Much progress had taken place in that direction, but logical development had been hindered because the expense involved only gave a financial return when applied on a large scale. Notable exceptions were the few large electric power stations which had grown up during the past ten years. One power station in the United States had gone over wholly to pulverised fuel, and trial installations were being tested in power stations in this country.

A considerable portion of the paper was devoted to mechanical stokers, the chief characteristics of each of the principal types being described. The question of high-speed gases came into prominence owing to the work of the late Professor Nicolson and the practical application of high-speed gases in the Bonecourt boiler. In that connection the author said water gauge pressures from 12in. to 20in. had been proposed or used. The latter figure would involve the use of power equal to 3.8 per cent., which would require a drop in temperature over the low draught of about 131 deg. Fah. to balance the account. There were so many sources of exhaust steam for heating the feed in a modern power station, that it was not possible to add with efficiency another steam-using auxiliary. The extra cost and upkeep of such a system reduced the value of the recovered heat in the commercial balance. There was another limit, viz., the dew-point of the flue gases, which occurred with practically dry coal with temperatures at 113 deg. Fah. to 88 deg. Fah. In the special cases where steam jets were used for producing forced draught, or with some special fuels, such as coke oven or producer gas, the dew-points were much higher. As a low final temperature could only be obtained on the contra-flow principle, the coldest gases must be adjacent to the coldest water. Since, as was known from heat transmission experiments, the film of gases next the surface tended to approximate to the temperature of the surface, that was, nearly to the inlet temperature of the feed, the feed must be kept above the dew-point temperature to prevent consequent condensation, and its attendant corrosion due to the acid in the flue gases.

Since increasing the feed temperature increased the exit temperature of the gases, that circumstance constituted a practical limit of efficiency, especially in cases of flue gases containing added steam. The matter had not much effect in every-day practice, owing to the common use of hot feed or the National Boiler Company's economiser circulator, but it had a direct application to the use of high-speed gases. Since moderate speed gases could be reduced to 300 deg. Fah. with ample economiser surface and with not more than 2in. water gauge, it followed that the use of high-speed gases could only have a moderate field.

The paper was copiously illustrated, and gave rise to a fair discussion.

Manchester Association of Engineers

THE paper on "Boiler Plant Efficiency," which was read by Mr. W. M. Selvey, Wh. Sc., before the Manchester Association of Engineers on Friday, the 8th inst., was of voluminous dimensions, and contained much valuable information. The author opened with a review of the investigations made during the past twenty-five years, mentioning the outstanding points in which progress had been made during that period. One of the most interesting features of the paper was a description of a method of attacking the problem of boiler efficiency by means of diagrams, the factors involved being explained. Under the heading of apparatus and aids to efficiency, Mr. Selvey described CO_2, temperature, and draught indicators or recorders, but he warned his audience that, generally speaking, if there was a real desire to make improvements, either to lower costs or increase output, it was much safer to take advice than to adopt apparatus solely on the recommendation of the selling interest. In most circumstances, however, the author said a case could be made out for using an economiser. It would not affect the flue gas analysis, but would reduce the temperature of the gases from about 400 deg. Fah. to 300 deg. Fah. A large economiser was described as an insurance against bad firing, as it always tended to check or minimise the loss of efficiency caused by bad furnace conditions and leaky settings in the case of Lancashire boilers.

Semi-Outdoor Sub-Stations.

SOME sub-stations which have been built by the Oerlikon Company at Valenciennes and Jeumont in the North of France, are designed on interesting lines, for all the gear, such as isolating switches, lightning arresters, and their water resistances, and resistances for earthing the system are mounted in the open, whilst the remainder of the equipment, including the transformers, is under cover. The plant at each sub-station consists of three 5000 kilovolt-ampère three-phase transformers, with a ratio of 48,000/10,000 volts. The original design for the sub-stations was submitted by the Oerlikon Company to the Service de la Commission Technique des Sociétés d'Energie Electrique in 1919, and in accordance with the usual practice in connection with 48,000 volt systems, it was proposed to place the equipment in a suitably constructed building.

It was found, however, when preparing the estimate that, owing to the prevailing high cost of buildings, the amount of money that would have to be spent in building work would be altogether out of proportion to the cost of the remainder of the equipment, and this led the contractors to consider whether the outdoor design of sub-stations would prove advantageous. A rough calculation showed that a considerable saving would result, and that the time taken to erect the sub-stations would be appreciably reduced. A new design was, therefore, prepared, but it was subsequently discovered that considerable difficulty would be experienced in obtaining the special bushing insulators. Suitable bushing insulators could have been obtained from America, but their cost would have greatly impaired the saving resulting from the adoption of the outdoor design. Bushing insulators could have been purchased in Europe at much lower cost, but the long period which the manufacturers required for delivery could not be tolerated. Finally it was, therefore, decided to erect semi-outdoor sub-stations. Originally it was proposed to lead the conductors into the cubicles through side openings, protected against rain. Owing to lack of room, however, it was found necessary to bring the conductors through the top of the cubicles. The use of bushing insulators, therefore, again became necessary, although in this case the number required was reduced, and as they were merely used for leading conductors from one air space to another, the task of installing them was simpler than if they had been employed for leading conductors from an air space into oil. Moreover, in the event of any delay in the delivery of the proper insulators, ordinary insulators, such as those used for indoor work, could have been employed.

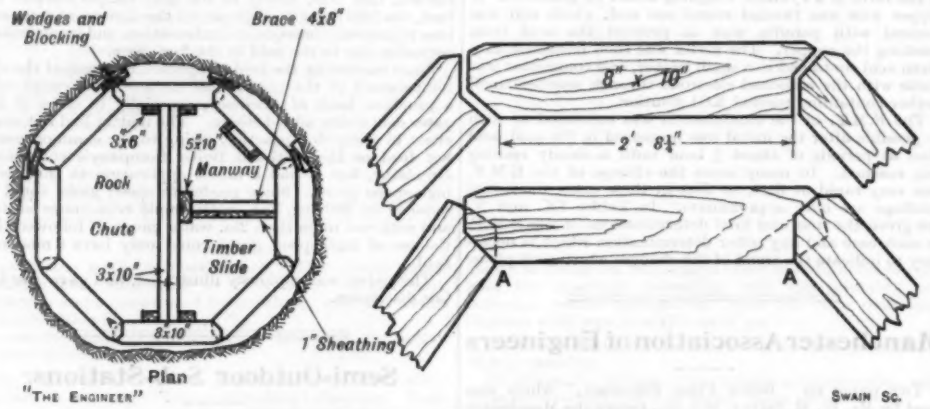
Although these semi-outdoor sub-stations were built to meet special conditions resulting from the war, it is thought that sub-stations of this type may prove advantageous under normal conditions when medium pressures have to be dealt with. Semi-automatic sub-stations, the engineers of the Oerlikon Company point out, are more immune from fire than ordinary outdoor sub-stations, and also more effectively protect delicate parts of the installation against atmospheric influences. The Oerlikon Company has, however, devoted a considerable amount of attention to purely outdoor sub-stations, and has at present important installations of this kind in hand.

WE have more than once referred to the misfortunes of the East London Railway during the control period. Its electrification was not completed in 1913, and so the receipts for that year, which determined the payments during control, were much less than the railway was earning in 1914 and subsequently. Efforts, backed by the personal influence of Lord Claud Hamilton, the chairman, failed to get better terms, but the company has now been awarded £133,367.

Octagonal Shaft at an American Mine.

To provide improved ventilating facilities at the Colorado copper mine near Butte, it was decided to sink a new ventilation shaft about 1800ft. deep, and the original plan provided for a timbered two-compartment shaft, each compartment to be 4½ft. by 5ft. in the clear. It was suggested by Mr. A. S. Richardson, the consulting engineer, that the cross section could be reduced without sacrificing air capacity by the construction of a circular shaft with concrete lining. This plan was held to be impracticable on account of the cost and time required, but the suggestion led to the adoption of an octagonal section with smooth timber lining. The octagon is circumscribed about a circle having a diameter of 6½ft., its cross sectional area being 34½ square feet.

A timber lining 10in. thick had been planned for the two-compartment shaft. But it was decided that an 8in. lining would give the same strength of support in the octagonal shaft, as the span of timber would be less than 3ft. instead of 4½ft. to 5ft., the size of excavation would be about one-third less, and the natural arching of the rock



TIMBER LINING FOR AN OCTAGONAL MINE SHAFT

would be more effective on account of the circular shape. The estimates showed also that the rectangular shaft would require about 50 per cent. more excavation and 72 per cent. more timber. The section of this shaft is shown in the accompanying drawing, and the description is compiled from a paper by Mr. J. L. Bruce, read before the American Institute of Mining and Metallurgical Engineers.

The timbering is of 8in. by 10in. fir, and as about 17,000 pieces were required for the shaft lining alone it was important to avoid as much waste as possible in cutting the pieces so as to frame together. The halved joint commonly used for wall plates and end plates would have involved prohibitive cost. Mitre joints would have left a continuous vertical joint at each of the eight corners and would have been unstable and unreliable for distributing the pressure. The style of framing adopted, as shown in the drawing, gave at each corner of the shaft a joint which could not easily be displaced. By reversing the timbers in alternate courses the joints were broken vertically at 10in. intervals, as indicated by the dotted line at A. This construction proved entirely satisfactory. The total waste in cutting amounted to only 5 per cent.

In placing the timbering it soon became apparent that the variation in thickness of the rough timbers—if not compensated—would cause the timbering to build high at one side and thus give a tendency to throw the lining out of plumb. This might have been corrected by sizing one side and one edge of the timbers before framing, but as that course was not convenient it was decided to sort the framed timbers into piles of uniform thickness, each raise taking all its timbers from one pile. The octagon was divided into three compartments, as shown. A compartment for the waste or spoil chute occupied half the area, the other half being divided into a manway and a compartment for handling timber. The chute wall was of double 3in. by 10in. planking. The other two compartments were separated by 1in. sheathing plank nailed to the braces, thus giving a division for upcast and downcast air currents to improve the ventilation. After completion of the shaft all the timbering inside of the octagonal lining was removed and used for other purposes in the mine. The waste rock in the chute caused very little wear on the shaft lining.

All of the shaft work was done by raising, with the exception of 90ft. sunk from the surface to meet the raise from the 300ft. level and 12ft. sunk from the 1500ft. level to meet the raise from the 1700ft. level. Work was started at various raises from September 3rd to September 24th, 1920, and the shaft was completed February 16th, 1921. The cleaning out, cribbing of stations, setting doors at cross cuts and placing drain pipes was then carried on rapidly, so that the exhaust fan was started March 21st. With this plan of working from nine levels it was necessary to construct at each level a working station at which the waste rock could be drawn off from the bottom of the chute and where a small hoist could be placed for handling timbers and tools. These station sets were carried on sills 14ft. long in order to have substantial support when holing through the raise from the level beneath. At the conclusion of the raise the station timbers were removed, with the exception of the sills, posts and top frame. The octagonal lining was then carried up through the station, leaving a door opening on the side next the cross cut.

Stope hammers using 1¼in. cruciform steel were used in driving the raises, the method being to drill a four-hole centre cut with eight other holes placed above the eight corners of the raise and pointing slightly outwards from the centre. Small air hoists with gin poles at the top of the raise were used to handle timber. Rock drills were used in driving the cross cuts from the levels to the shaft. In raising, three men on each shift constituted the crew, two working in the raise and the third operating the hoist and tramming the waste rock. The chutes were kept nearly full, the rock in them being drawn down before each blasting just enough to make room for the additional rock. When blasting, the manway and timber slide were covered, a sufficient number of planks being left out of the chute lining to enable the men to get through after the blast.

At intervals of about 100ft. the plumb of the timbering was checked by the engineers, by means of two plumb lines hung in the manway and timber slide. Near the bottom of the raise a straight-edge was placed just free from contact with the wires. Two corners were located by taking the angles from the straight-edge through each wire to these corners with an adjustable bevel square and by measuring the distances to the corners. These points were then projected to a point near the top of the raise by duplicating the angles and distances on a similar straight edge set in line with the wires just below the top of the timbering.

Before the shaft was commenced re-surveys of all levels down to the bottom of the proposed shaft were made by carrying meridian lines down the main shaft by means of plumb wires hung about 3ft. apart and carried down not more than 400ft. for each plumbing. These lines were rechecked until the meridians agreed within a limit of 3in., this being considered satisfactory in view of the strong air current in the shaft and the short base lines. That this limit was sufficient was shown by the fact that none of the raise connections were in error by as much as 3in.

All woodwork in the vicinity of the new downcast shaft was coated with a fire-resisting paint, and under the collar of the shaft is a ring of 4in. pipe perforated so as to distribute water thoroughly around the shaft timbering. As the shaft is smooth lined and has a heavy condensation of water, the shaft is considered to be practically fireproof.

Administration of the Road Fund During the Year 1921-22.

THE report issued by the Ministry of Transport on the administration of the Road Fund for the year April 1st, 1921, to March 31st, 1922, was presented to Parliament on December 11th. It covers the work of the Roads Department of the Ministry for the first complete financial year during which the new rates of licence duties on mechanically-propelled vehicles, imposed by the Finance Act, 1920, were operative. From it appears that the receipts credited to the Road Fund during the year amounted to £12,585,633, and the net payments to £9,922,393. The advances by way of grants and loans made during the year are grouped under the three following main headings :—

(1) Classification grants made towards the cost of maintenance and improvement of Class I. and II. roads, £8,108,027 ; (2) unemployment schemes, £4,531,103 ; (3) other purposes, £834,779 ; total grants made in 1921-22, £13,473,909 ; total payments under grants, £8,868,156 ; total loans, £741,026.

The grants toward the cost of maintenance and improvement of Class I. and II. roads and bridges represented 60.2 per cent. of the total grants made during the year. They were made on the basis of 50 per cent. of the approved cost in the case of Class I. roads and bridges and 25 per cent. in the case of Class II.

A special unemployment fund—road works—was provided for the winter of 1920-21, and in the autumn of 1921 a further sum of £2,000,000 was allocated from the Road Fund as follows :—(*a*) £1,000,000 to special road schemes in Essex and Kent, for the absorption of unemployed within the London County Council area ; (*b*) £1,000,000 for road works in the provinces.

On these two unemployment funds, the Road Fund liability amounts to £6,077,000, out of which commitments amounting to £4,341,000 remained to be liquidated on March 31st.

During the year, three Orders made under Sec. 1 for the acquisition of land required for the construction of new roads were confirmed by the Minister, and approval of entry into possession was given to seventy-seven local authorities. These approvals related to land required in connection with thirty-seven new and sixty-four existing roads. Had it not been for the powers conferred by the Act there can be no doubt that many important road schemes in various parts of the country, which have provided employment for a large number of men, could not have been put in hand without very serious delay.

During the same period 1504 applications, of an approximate total value of £10,500,000, for assistance to the cost of various road works were received by the Unemployment Grants Committee and examined by the Ministry. Most of them possessed local rather than national importance, and were thus more suitable for assistance from the Committee than the Road Fund. The Ministry recommended 1008 to the Committee and retained 164 for grants from the Road Fund.

During the calendar year 1921 the receipts from the taxation of road vehicles amounted to £10,212,458, and the estimated numbers of vehicles in respect of which licences were issued, were 873,665 mechanically propelled and 269,200 horse-drawn. The expenses of collection incurred by local authorities during the financial year 1921–22 were £291,325, or 3 per cent. of the amount collected. The net revenue, after payment of prior charges, &c., was approximately £9,000,000.

With the institution of large grants towards the cost of maintenance of classified roads, it became imperative to apply the principle of decentralisation. Divisional offices were, therefore, opened at Bristol for the South and South-West Division, at Birmingham for the Midland Division, at Leeds for the Northern Division, and at Cardiff for Wales. These were in addition to the existing office at Edinburgh. The London and the Eastern and Home Counties Divisions were placed at headquarters.

The Divisional Road Engineers examine and approve the estimates for work on classified roads ; satisfy themselves that the works have been properly carried out ; investigate applications for grants toward the cost of new road construction and other improvements outside the "classification" scheme—*e.g.*, works for the relief of unemployment ; investigate into the more serious road accidents ; examine town-planning proposals, and by conferences with the local authorities frequently obtain concerted action where agreement between conflicting interests is otherwise unobtainable.

The final revision of the classification scheme has made it possible to proceed with the assigning of route numbers to all Class I. and II. roads. These numbers are beginning to appear on many direction posts, and arrangements have been made for the publication of official maps by the Ordnance Survey Department, showing Class I. and II. roads in distinctive colours, together with their route numbers. During the year County Councils showed a marked tendency toward the adoption of Class I. and II. roads as "main" roads. The effect of this policy was to spread the cost of road maintenance over larger areas, and to place the control of increasing lengths of important highways in the hands of the larger local authorities which are in a position to adopt more comprehensive programmes.

A large number of schemes have been under consideration for the improvement, strengthening or reconstruction of highway bridges, many of which fall considerably short of modern traffic requirements. In this connection a standardised loading was prepared, the aim being to ensure that no restriction need be imposed on the use of the bridge. As a bridge is the most important link on the highway chain and a life of at least 100 years should be anticipated, allowance has had to be made for the more onerous loading which may be expected in coming years. The load specified is one traction engine and three trailers to which 50 per cent. has been added for impact. This 50 per cent. is an empirical figure, but it is hoped to substitute an appropriate formula as the result of experiments now proceeding. Bridges over canals and railways maintainable by the companies presented special difficulties, but conferences were held with a view to their solution.

It may also be mentioned that with regard to carriageways generally the Ministry is now recommending a standard width based on a unit of 10ft. per line of traffic—a point on which local authorities have long been seeking guidance.

The Advisory Committee on London Traffic, as a whole, has ceased to meet, but one of its sub-committees continues to investgaite a variety of questions connected with the working of London traffic agencies. It is found that its recommendations are almost invariably adopted by the authorities concerned, and numerous appeals are made to them for guidance and advice. Details of the progress in the case of eight of the more important schemes commenced in 1920–21 are given in paragraph 41. In the autumn of 1921 the need for further large works in the metropolitan area to meet unemployment became apparent, but their selection was difficult owing to the built-up conditions prevailing. In October, 1921, however, definite proposals were made for works in Essex and Kent toward which the London County Council agreed to contribute £500,000 out of £2,250,000, on condition that the unskilled labour was recruited in the administrative county of London. The Town Council of Southend agreed to contribute £100,000. Contributions were also made by other local authorities. The execution of these works was left in the hands of the Ministry. Details of the six schemes taken in hand are set out in the report. Arrangements were made with railway companies and contractors for the transport of the men to and from their work, and special canteen arrangements were also provided. The scheme, which possesses many unusual features, has worked smoothly, and an unexpectedly high output has been secured from the unemployed men engaged. Details of the progress on (*a*) the Great West road, (*b*) the Chertsey road, (*c*) the Croydon Byepass, and various other works are also given. The total number of schemes for the provinces approved up to March 31st, 1922, was over 550. The commitments of the Road Fund at that date were approximately £4,290,000 by way of grants and £1,390,000 by way of loans. Details of some of the more important money schemes are given.

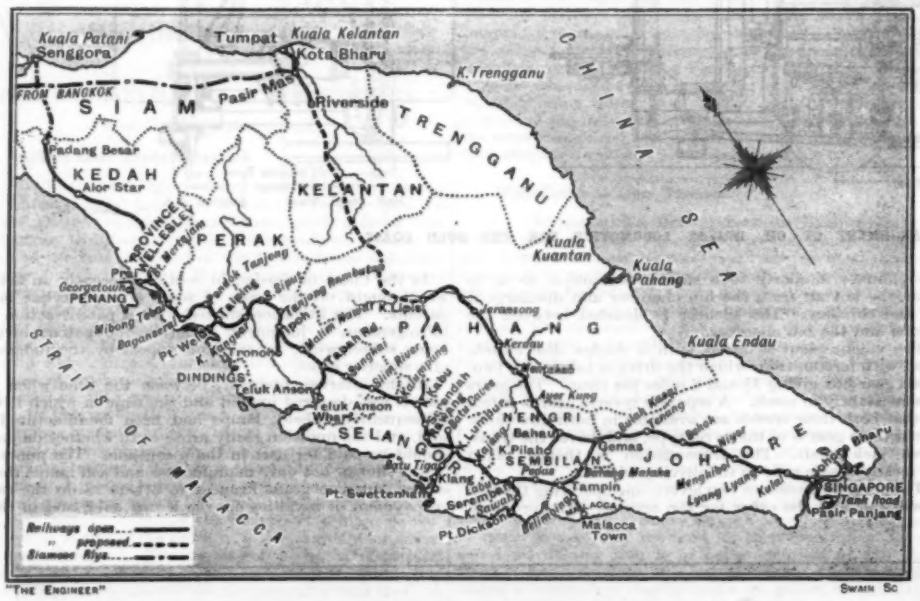
It may be added that copies of the report may be obtained at H.M. Stationery Office, price 2s. 6d. each.

AMONG the nominations made by President Cosgrove to the Senate of the Irish Free State are Mr. J. Bagwell, the general manager of the Great Northern Railway (of Ireland), and Mr. H. G. Burgess, of the London and North-Western Railway. Among those elected by the Chamber of Deputies were :—Sir John Purser Griffith, late chief engineer of the Dublin Port and Docks Board ; Mr. W. Barrington, a Dublin civil engineer and engineer of three small Irish railways ; Mr. Thomas O'Farrell, secretary to the Irish branch of the Railway Clerks' Association ; and Mr. Michael O'Dea, who signed the minority report as to the Irish railways.

Federated Malay States Railways—Annual Report.

ALTHOUGH the Federated Malay States in 1921 passed through a period of depression unparalleled in their interesting history, the administration carried on its policy of railway development to open up new areas for exploitation by mining and agriculture.

The Federated Malay States are justly proud of having constructed their fine railway system out of income. Although from time to time loans have been talked about for the purpose of accelerating the construction of the railways and connected works, it was not until last year that, largely owing to the universal depression in trade and the consequent low prices obtainable for tin and rubber, which have been the mainstays of the country, it became necessary to obtain a loan in London. While it is literally true that the railways have been financed from income, yet it must be said that, strictly speaking, the country has been drawing on its capital for this purpose to a very large extent. Before rubber became such an important industry it was upon the rich alluvial tin deposits that the Federated Malay States depended almost entirely for their income, directly and indirectly. During the years 1889–1920 these States received as export duty on tin approximately 220 million dollars, equivalent at the present rate of exchange to more than 25¼ millions sterling, and it may be said that practically all of this income has been put back into railways and other capital works, for which most other countries would have had to borrow. The advantage of building railways out of income is that, not having to provide interest on capital, the policy of the railway administration can be framed more with a view to develop the country than to make the railway a revenue-earning undertaking. This has been the policy in the past. It has led, of course, to a certain amount of criticism, as was only natural, especially when the arrival of the trade depression found the country committed to considerable expenditure on railway works in progress which could not be stopped without serious loss in the way of damages for breaking contracts. The Federated Malay States, when trade revives, will consequently be well up to their requirements in the way of railway and road transport. Before the depression which commenced in 1920, the fear was that the railways would be quite unable to meet the increase of traffic which was expected; but when trade revives the progress of the country will not be retarded by want of means of communication. It is expected that by 1924 the Causeway over Johore Straits, now under construction—see THE ENGINEER for April 30th, 1920, and August 4th, 1922—will be completed, and it will then be possible for travellers to proceed from Singapore to Bangkok without changing carriages. The works at Prai—see THE ENGINEER for the dates just mentioned—which is on the mainland opposite to the island of Penang, will, it is hoped, be completed about the same time. These two works, which are being done under contract, will complete the essential communication of Malaya, and, if necessary, further railway construction can be indefinitely postponed. For the convenience of our readers we reproduce the map used to illustrate the article which appeared in August last.



MAP OF FEDERATED MALAY STATES RAILWAYS

LAST YEAR'S WORKING.

The working account of the railways in 1921 showed a net profit of only £58,514, which represents 0.29 per cent. on the total capital expenditure, as against £65,704 in 1920, or 0.39 per cent. But during the past year no less a sum than £3,482,353 was laid out as capital expenditure, as compared with £2,386,156 in 1920. Of this amount, £815,018 was in respect of the construction of new lines, £1,854,089 for widenings and additions, including wharves, &c., at Prai, in Province Wellesley, and the Johore Causeway, and £613,318 for new rolling stock. The total capital expenditure to December 31st last amounted to £20,298,060.

The principal items of expenditure under the heading of special service works included a new firewood depôt at Port Swettenham, a water supply to the central workshops at Kuala Lumpur, signalling wayside stations, a new goods yard at Tanjong Malim, a new engine shed and additional sidings at Port Swettenham, and the relaying of the branch line to Teluk Anson.

Electric lighting was also installed in a large number of stations, quarters, signal cabins, &c., and electrical machinery and plant erected at various places on the railway system. The total length of railway telegraph, telephone, tablet, bell and repeater wires was 4154 miles, an increase of 405 miles during the year. Ten new telegraph offices were opened, making a total of 251; and the construction of a telegraph line for the Trengganu Government was undertaken and satisfactorily completed for a distance of 100 miles from the linehead to the Pahang boundary. Fifty-four new telephones were installed.

EAST COAST RAILWAY.

A sum of £505,244 was spent on the extension of the Kelantan section of the new East Coast Railway. This railway starts from Tumpat and proceeds southwards towards Kuala Lipis in Pahang, the distance from Tumpat to the boundary of Pahang being 140¾ miles, of which 32 miles were opened in 1915. Stopped for three years during the war, construction was resumed in January, 1918. Earthwork is completed to the 57th mile and permanent way for 52½ miles. Kelantan bridge consists of five spans of 250ft. and five spans of 150ft. Good progress was made with this, in spite of the fact that work towards the end of the year had to be slowed down. Foundations for all piers and abutments are in process of construction, and the steel work for the superstructure has been delivered. Kelantan is already connected with the Siamese railway system at the Golok River, where the joint bridge was completed in July, 1921, and opened for through traffic over the Siamese line to the Federated Malay States system on the west coast.

In Pahang, where the section from Gemas to Kuala Lipis had been opened in 1917 for a distance of 141¼ miles, progress was made with the northward extension. The distance from Kuala Lipis to the Pahang-Kelantan boundary is 46½ miles, and the total distance from Kuala Lipis to Tumpat (in Kelantan) is 186¾ miles. The distance from railhead in Pahang to railhead in Kelantan was 107½ miles at the end of the year. Work was closed down in August owing to the financial situation, but out of 2,567,789 cubic yards of earthwork, 2,558,693 cubic yards had been excavated and, in addition, 9186 cubic yards of rock. The permanent way has been laid as far as mile 168.2 from Gemas. Bridges and culverts on the section between Padang Tungku and Chegar Prah are numerous. Good progress was made, only three bridges and three culverts remaining to be completed. The largest bridge is that over the Jelai River, which consists of two spans of 200ft. and two of 100ft. Expenditure on the Pahang section amounted to £228,471.

NEW CONSTRUCTIONAL WORK.

A sum of £151,404 was spent on doubling the line on Singapore Island, £62,509 on doubling the line between Port Swettenham and Kuala Lumpur, and £98,142 in doubling the line from Kuala Lumpur to Batu Junction and Sungei Besi. Towards a deviation of 5 miles rendered necessary at Kuala Kubu, £29,602 was expended, while £67,771 was spent on works connected with the Penang Hills Railway.

The contractors, Topham, Jones and Railton, Limited, made good progress with the construction of the jetty and other works at Prai, opposite Penang Island, but progress with the work additional to the wharves was impeded by the necessity of reducing expenditure. The expenditure on the Prai doubling, wharves, &c., amounted to £608,302. The same contractors maintained satisfactory progress with the construction of the Causeway across Johore Straits, which is to connect Singapore Island with the mainland. The sum expended there during the year was £265,378. The construction of the lock at Johore proceeded day and night throughout the year, the north wall, with the exception of the coping and surfacing, being completed, as well as the east wing wall as far as the powerhouse. During the period under review 30,570 cubic yards of excavation were removed from the site of the lock and 18,100 cubic yards of concrete were deposited. The depositing of granite rubble in the Causeway continued regularly during the year, and in all 295,394 cubic yards were put down, which brought the total at the end of the year up to 378,616 cubic yards.

Other works coming under the head of new construction were the building of (*a*) new engine and carriage sheds and staff quarters at Ipoh, on which £137,319 was spent; (*b*) new carriage and engine accommodation and quarters at Seremban, on which £106,055 was spent; (*c*) a water supply system for Prai and Bukit Mertajam, on which £140,462 was spent; and (*d*) six godowns at Teluk Ayer, Singapore, on which £150,022 was spent during the year. The new reservoir is situated at Bukit Serayah, about 4 miles from Bukit Mertajam. The plant for the building of the dam, consisting of concrete mixers, stone crushers, pneumatic drills for quarrying, pumps, winding engines, &c., has been delivered. The 10in. pipes for the water main from the reservoir to Prai, a distance of about 30 miles, have also been delivered and distributed on the site.

COMPARATIVE STATISTICS.

The total mileage of running lines—reduced to single track—open on December 31st last was 1022 miles 14 chains, including the Johore leased line, and of running lines and sidings 1162 miles 39 chains, against 1014 miles 67 chains and 1150 miles 71 chains respectively at the end of 1920. There are now open for traffic 232 permanent stations and 18 flag stations or halts.

The number of ordinary passengers carried showed a decrease of 2,850,417, or 21.27 per cent., as compared with 1920. The passenger receipts decreased by £250,692, or 23.53 per cent., and the total receipts from all sources amounted to £1,889,816, compared with £2,020,262 in 1920, while revenue expenditure amounted to £1,831,301.

The cost of fuel per engine mile decreased from 39 cents to 32 cents, and the total running costs per engine mile were 59 cents, compared with 64 cents in 1920.* The total engine mileage, including maintenance ballast miles for the year under review, was 5,694,359, as compared with 5,666,121 in 1920. The train mileage in relation to traffic receipts was 3,944,990, as against 3,940,732 in 1920. The daily average miles per engine actually at work was 107.47, as against 108.6 in 1920.

The following table gives comparative statistics showing the growth of the Federated Malay States railway system since 1912:—

	1912.	1921.
Miles open to traffic	734	1,022
Number of stations	161	232
Number of engines	128	251
Bogie passenger coaches	274	416
Four-wheeled carriages	66	38
Other coaching vehicles	—	141
Goods vehicles	3,067	5,051
Train mileage	3,194,200	4,520,788
Passengers	11,589,273	10,551,115
Season tickets	—	10,710
Merchandise carried, tons	988,416	1,540,528
Cattle, head	128,604	124,719

The following table shows the gross receipts, net profits, and the amount spent on construction and surveys:—

	1912.	1921.
	£	£
Gross receipts	957,635	1,333,499
Net profits	314,037	58,514
Construction and surveys	529,077	2,559,583

STORES.

The total disbursements for working stores purchased from Canada and Australia in 1921 were:—Canada, £2910; Australia, £3493. Including the balances from the previous year, the amounts still remaining to be absorbed at the close of 1921 being £60 and £86,717 respectively. Under special services account, twenty "L" class locomotives were received from the North British Locomotive Works, Scotland, and ten "B" class from the Baldwin Locomotive Works, Philadelphia. Ten "M" class locomotives ordered for the Construction Department in 1920 were received and erected during the year. A large amount of new machinery was installed at the works in 1921, and, in addition to various coaching and merchandise and mineral vehicles constructed in the railway works locally, 160 steel-covered goods wagons were erected at Port Swettenham by Messrs. D. G. Robertson and Co., of Kuala Lumpur. These wagons are part of the 500 steel-covered goods ordered from England in 1919.

* The dollar has a fixed value of 2s. 4d.

A ROTARY PETROL PUMP.

A VERY simple form of rotary pump, which, it is claimed, will handle practically any liquid, including petrol, has recently been brought out by the Avamore Pump Company, Limited, of Sicklemill Works, Haslemere, Surrey.

The pump comprises a short cylindrical casing, divided into two compartments by a diaphragm, through the centre of which runs a shaft. The shaft has two excentrics corresponding with the two compartments of the casing. On each excentric there is slipped a loose-fitting disc of a diameter slightly less than that of the casing. These discs will naturally roll round inside the casing as the shaft is rotated, and the crescent-shaped space between each disc and the casing, formed by their difference in diameter, will follow in the same direction. By providing an inlet and an outlet close to one another near the top of the casing, and a shutter between them, that always makes contact with the disc, and thus shuts off the inlet from direct communication with the outlet, all the essentials of a pump are provided.

The arrangement has the great advantage that the fastest moving part, the disc, has a purely rolling action on the casing, and the only place where there is any great amount of rubbing is where the shutter presses on the disc. The shaft can, of course, be run in ball bearings, and there might be balls in the bearings between the excentrics and the discs if it were worth while, but the relative motion of the two is comparatively slow. It is thus evident that the pump is well suited for pumping such liquids as petrol, which have no lubricating qualities.

The mechanical construction of the pump is so simple that it needs hardly any description. The two cover plates, which close the ends of the casing, are duplicates, and carry the bearings for the shaft, which, also, is symmetrical, and can thus be driven from either end. A lubricator is provided for oiling the shutter between the inlet and the outlet.

The pump is made in several sizes, ranging from ¾in.

to 4in., which will deliver 300 gallons and 11,000 gallons per hour respectively, the corresponding speeds ranging from about 1000 down to 600 revolutions per minute. From the results of tests carried out by the makers, it appears that the mechanical efficiency of these pumps ranges about 50 per cent.; but in one case the figures show an efficiency as high as 70 per cent. The pump in question delivered 55 gallons per minute against a total head of 81ft., and was driven by a motor giving 1.9 horse-power. It was tested against a suction head and actually produced a maximum vacuum of 29.31in. of mercury.

Oil Locomotives for the Gold Coast.

SOME locomotives, driven by internal combustion engines, which have recently been supplied to the Crown Agents for the Gold Coast Colony, for service on the Takoradi Harbour scheme, and which possess some unusual features, are illustrated by the accompanying half tone engravings and line drawing.

These engines, by McEwan Pratt and Co., Limited, of 13, South-place, London, E.C.2, have, it will be noticed, much the appearance of steam locomotives, but the illusion has been, we are told, produced incidentally to the most convenient grouping of the various parts, rather than by design. It will also be observed that the system of transmission is through a jack shaft and side rods, an arrangement which the makers have adopted for locomotive work as being most suitable for comparatively slow speeds. For higher speeds and lighter work a chain drive is, however, advocated. Such a drive was described in our issue of July 8th, 1921, in connection with a rail car for Simla, made by the Drewry Car Company, associated with McEwan, Pratt and Co. The four driving wheels of the locomotive under review are coupled and have a wheel base of 4ft., while the gauge is 3ft. 6in.

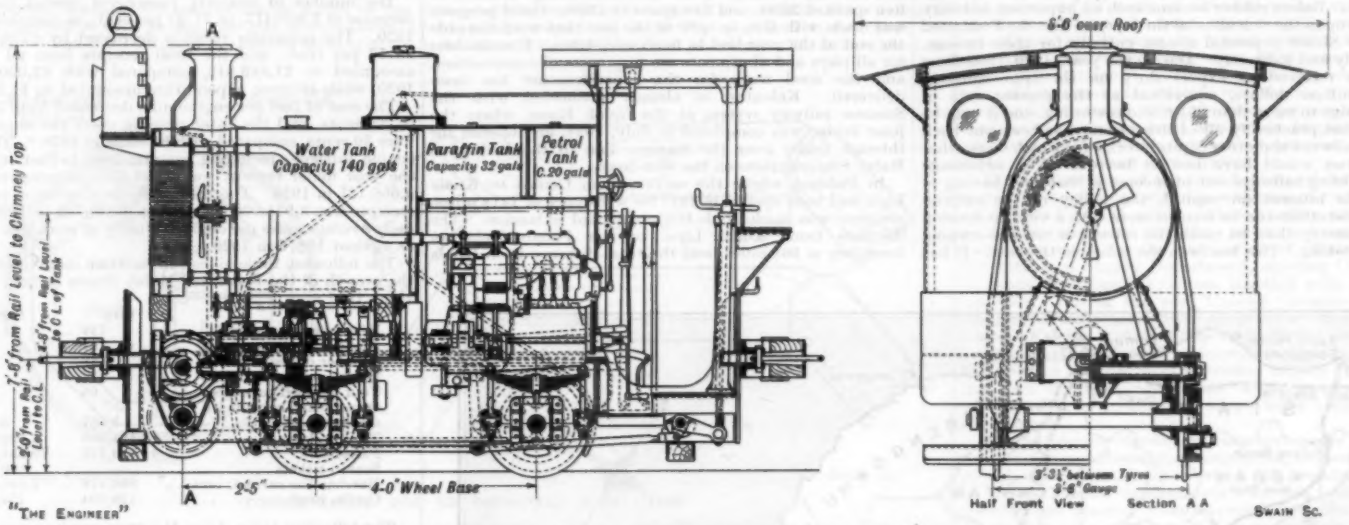
The engine, by the same makers, is, it will be seen, arranged towards the rear of the locomotive, and has been specially designed for the service. It has cylinders 4¼in. in diameter by 5½in. stroke. The output is from 38 to 40 horse-power when running on petrol, and about 10 per cent. less with paraffin fuel. Starting is effected with petrol, and when the engine has warmed up it is switched over on to paraffin. The consumption of fuel is, according to the makers, 0.6 pint per brake horse-power per hour. The cylinders are of cast iron, cast complete with their water jackets, and the valves are all on one side. The pistons are of cast iron, fitted with three cast iron rings, and have hollow hardened steel gudgeon pins. The connecting-rods are of high tensile steel "H" section, fitted with a phosphor bronze bush at the small end, and adjustable white metal lined brasses at the big end. The connecting-rod bolts are nickel steel. The crank shaft is of solid forged nickel chrome steel, and is supported on five gun-metal bearings lined with white metal. The valves are of nickel steel, the inlet and exhaust being interchangeable. The crank case is of cast iron. Ignition is effected by a Simms high-tension magneto and trip starter. The lubrication of the engine is by gear pump, the crank shaft being drilled for the oil supply.

In view of the heat of the climate in which the locomotives have to work, the cooling arrangements have to be of ample capacity, and a special design was evolved for the purpose. There is a large tank containing 140 gals. of water, which is circulated from the engine through a water delivery pipe. This pipe passes through the water in the tank to the top of the radiator. The water then falls from the radiator to the tank, and is again delivered to the engine by the pump. A fan is fitted behind the radiator in the space between the water tank and the radiator, and the exhaust from the engine is carried up to the chimney similarly to a steam locomotive, so as to draw the hot air from the fan chamber and discharge it up the chimney. The silencer is situated between the engine and the fan chamber.

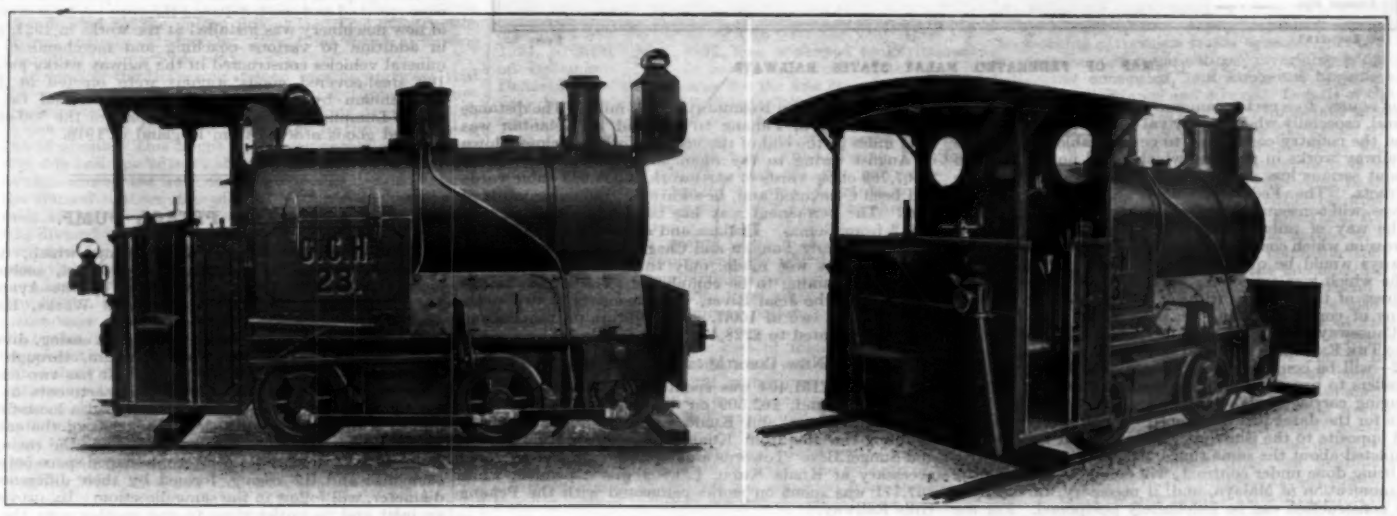
The engine shaft is fitted with a duplex disc clutch, lined with ferodo, from which the drive is taken to a two-speed gear box giving 3½ and 8 miles per hour. The gears run constantly in mesh. A separate reverse gear is fitted, so that both these speeds are available in both directions. The reverse gear is of the bevel type, and drives the transverse jack shaft. The transmission is thence taken by means of side rods to the driving wheels.

The control consists of two levers, one operating the two speed gear and the other for the reverse. The ordinary engine clutch and clutch pedal is thus entirely dispensed with, and in order to drive the locomotive, after setting the reverse lever in the required direction, it is only necessary to move the gear lever into the required position for neutral, low speed, or high speed, as the case may be, the engine throttle being moved at the same time to accord with the load and speed. The arrangement has the advantage that the change of speed can be made so quickly that loss of momentum is avoided. This is, of course, specially important when mounting a gradient, and it is found necessary to change into low gear.

The frame is of the ordinary locomotive plate type, the plates being ⅜in. thick, secured by cross stays, angles, and gussets. The buffer beams are of steel plate, and fitted with central combined spring and draw gear. The wheels are of cast iron, fitted with rolled steel tires. The axles are of steel, in accordance with the British standard specification for English main line straight axles. The wheels are pressed on the axles by hydraulic pressure. The locomotive is fitted with a hand screw brake working on all wheels. The axle boxes and guides are of cast iron, while the boxes are fitted with heavy phosphor bronze bearings lined with white metal and arranged for syphon lubrication. There is also a spring oil pad for each bearing. The guides are securely bolted to the frame by turned bolts. The cab has a double roof for protection from the sun. The fuel tanks have capacity for 32 gals. of paraffin and 10 gals. of petrol. The engine is fitted with a sand box on the top of the water tank, to sand the four wheels running in each direction. The weight of the locomotive in running order is 6¼ tons.



GENERAL ARRANGEMENT OF OIL DRIVEN LOCOMOTIVE FOR THE GOLD COAST



OIL DRIVEN LOCOMOTIVE FOR HARBOUR WORK ON THE GOLD COAST

Infringement of Letters Patent.

THE half-watt lamp litigation and other actions relating to electric lamps have resulted in decisions being given from which much can be learned by others manufacturing commodities likely to infringe letters patent in force.

In the Court of Session in Scotland recently an action was brought on the basis of some of the electric lamp patents. The litigation started with a patent action for infringement, a judgment declaring the patent invalid being subsequently reversed on appeal by the judgment of a superior court.

In the interval, however, between the time when the patent was declared invalid and the time in which it was subsequently upheld, lamps had been manufactured or sold, and the question really arose as to whether damages should be paid for user in the meantime. The pursuers, it was shown, not only manufacture and sell lamps themselves, but also grant licences to others to do the same on payment of royalties on the lamps sold, and in these actions, according to the official report of the judgment now available, they elected to measure the damage suffered by the amount of royalties they would have received had the defenders been their licencees and as such entitled to use their patents. It appeared that the licence covered a whole series of patents, and the licencees could make use of what they wished.

The licence provided for royalty to the pursuers, that is, the patentees, of 10 per cent. of the net selling price before deducting cash discounts of each lamp sold by the licencees in the United Kingdom. Apparently in addition it was proved that as well as the payment of the 10 per cent., the licencees were restricted as to the number of lamps they might manufacture, and also as to the minimum price to be charged for the lamps. At that time, before calculating the 10 per cent. royalty, certain discounts were taken off the price, amounting in some cases to as much as 30 per cent., the average figure being about 30 per cent., an additional cash discount of 25 per cent. of the royalty being allowed.

It was argued by the defenders that first the uniform

royalty of 10 per cent. was not reasonable because all the patents could not be used in one lamp, and also that as they were advised after the judgment, which held the patent to be void, that they might safely manufacture, they ought only to be compelled to pay nominal damages. Further, as it was their intention to pay immediately on a decree being granted, they should be allowed the cash reduction. Lord Blackburn held that the infringers ought to pay damages in full in respect of their infringement during the period from the date of the judgment of the Court of Appeal, and that the pursuers were entitled to damages in respect of the infringements on the basis of the full royalty, no allowance being made for a cash payment because the argument did not appear justified in the absence of the defenders having tendered the royalty with the reduced payment immediately on demand by the pursuers. The case is apparently subject to appeal in Scotland and to the House of Lords in England.

The same general litigation also involved another point which is rather novel, namely, infringement by exportation. It appeared that the infringers had imported lamps from abroad or lamps had been sent in mistake, and in view of certain circumstances the patentees sought to have it made clear that the defenders were not entitled to deal in these lamps. It seems that the importers were not satisfied to accept a decision that they might be free to re-export lamps sent in mistake, but they frankly explained that while they had no intention of importing for use or sale in this country, their desire was to be free in the matter of exportation from it.

The matter was argued at very considerable length, both in the Inner and Outer Houses in the Court of Session in Scotland, and it was held by three of the judges that in the circumstances of the case and in view of the wide right to export asked for by the infringers that the latter should be restrained. From this view, however, one judge dissented.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Anxious Coal Trade Situation.

FOLLOWING upon what I said under the heading of "Latest News" last week about the Premier and the colliers, there is no doubt that the coal trade is faced with an anxious situation. This is the considered opinion of many of the best informed of the Midland coal and iron-masters, and on 'Change in Birmingham to-day (Thursday) wide expression was given to the conviction. Interest now centres in the national delegate conference called by the Miners' Federation Executive at Southport for the 21st inst. What steps the delegates may then take to forward their demand for increased wages is the subject this week of much speculation in Midland and Staffordshire trade circles. The urgent full-dress debate in Parliament which the Labour Party desires to air the miners' grievances is a further evidence of the critical nature of the present position. It is recognised that what the extremists amongst the colliers' leaders are after is the actual serving of the oft-talked-of notice upon the coalowners to end the existing agreement which has been in operation since the last coal strike. Whether the Southport conference will advise this course is the problem which is this week being anxiously discussed. The iniquity of the last strike, which brought all the blast-furnaces of the kingdom, with a few absolutely solitary exceptions, to a stand is still fresh in the minds of Midland ironmasters. A heavy percentage of the unemployment prevalent to-day can be laid at the door of that great struggle. The iron and steel trades have never recovered the attack then made upon them. It is easy, therefore, in face of fresh threatened trouble by the colliers, to explain the anxiety which is now showing itself in Midland iron and steel no less than coal trade circles.

Raw Steel Prices Moving Up.

Small steel is better, both rolled and semis, and values are moving upwards. During the past week there has been more business done than for a considerable time past. Buyers appear to have increased confidence, and steelmasters are more optimistic and inclined to the opinion that at last the industry is making progress towards recovery. Buying has been very active, and a shortage has unexpectedly developed in the case of billets. Several big producers are off the market, having filled their order books as far as they care to. The increased demand for semi-finished material also coincides with what is almost a withdrawal of continental offers. These circumstances have led some of the steel works to increase their prices. Some firms are this week asking as much as £7 15s. for ordinary mild billets. Quantities can still be bought at £7 2s. 6d., but only in exceptional cases is this price accepted, the general minimum appearing to be £7 5s. for Welsh billets delivered in this district. Sheet bars have likewise appreciated, about £7 2s. 6d. being the current price. Hard billets have advanced by 10s. per ton, the present price being £8 15s. A determined attempt is being made to put small steel bars on an economic basis. Houses which were recently quoting £8 15s. are now asking £9, and in some cases even up to £9 5s. Foreign competition is still maintained to some small extent, and is expected to increase if British prices continue to advance. There is still so much idle plant in the steel trade, however, that any large or rapid increase in prices is considered unlikely. A few negotiations are in progress for continental material on the basis of £6 15s. delivered. The matter is, however, influenced by inevitable delays in delivery. It does not appear that much new business, either in semi or finished material is going to Belgium. A free market in ship, bridge, and tank plates has undermined prices, the £9 10s. basis now being purely nominal. Scottish makers of boiler plates have reduced their price to £12 for Clyde delivery. In Birmingham the price remains £12 10s., which mill owners say is the lowest that production costs admit of.

Steel Scrap Dearer.

One result of the spurt in the steel trade is a revived demand for steel scrap, which not long since was a drug on the market, and could be bought at £2 2s. 6d. f.o.r. Recent sales have been on the basis of £3 2s. 6d.

Pig Iron Values and Coke Prices.

There was no easing of pig iron prices at the Birmingham iron market to-day (Thursday) on the strength of the relief in railway rates. Though consumers continued to press for a reduction, smelters were adamant, and pointed out the difficulty they were experiencing in getting fuel and the possibility of even further increases in values of this important material. Not only did they not give way, but, on the contrary, the tendency of prices was to greater firmness, and 6d. or 1s. more was asked for some brands of pig iron. This tightening up of values was, however, too sporadic to affect the general level of prices for ordinary makers of forge and foundry grades. Foundry numbers have this week been taken up steadily in small lots, and there is a disposition on the part of ironmasters to buy more forge iron. Consumers are not disposed to undertake large forward contracts, and the blast-furnacemen, from their point of view, have little inclination for large commitments. For the present they are endeavouring to raise their prices, and in some instances smelters claim to have been successful to the extent of an additional half-crown for foundry material, and from 1s. to 2s. on forge pig iron. The pig iron situation is still under the influence of American demand which, though it has fallen off somewhat, is still considerable. Orders for several hundred tons have been taken by Midland furnaces, in spite of the disadvantage of high railway rates. Prices are cut rather finely, but the business is useful in absorbing the regular output of the furnaces. In this district there is not much pig iron buying. The total output is so small, however, that the product is easily disposed of. The situation with regard to fuel is seriously perplexing those Midland smelters who have furnaces to feed. At the moment a shortage of coke is in evidence. Fancy prices are asked for prompt delivery, and for forward business suppliers quote something like 21s. at ovens, which is a considerable offset to the saving on transport. The possibility of even dearer fuel is not being overlooked by makers of pig iron, who are watching the development of the situation which has arisen as the result of the Premier's firm attitude towards the miners' demands.

Manufactured Iron Business.

Manufactured iron makers in Staffordshire are awaiting the coming of the New Year, which, it is hoped, will bring increased business. At the moment orders, though more numerous than they were a month or so ago, are none too plentiful, and only a proportion of the makers of best bar iron are kept fully employed. Although the marked bar standard of £13 10s. is disproportionately high compared with other descriptions, now that manufacturers have to pay increased wages under the recent ascertainment of the Midland Iron and Steel Wages Board, there is not much likelihood of it being lowered. The firm value of this material, it must be remembered, has proved a steadying factor in a critical situation. Quite recently it was stated that not more than one in twenty of the Staffordshire puddling furnaces was in commission. There have been no puddled bars on the open market for a long time past, as they could not be produced at a price which would pay. Furnace owners have simply puddled as much iron as they required for their own mills. Good merchant quality iron is in better demand at £10 10s. to £10 15s., the figure which is also asked for iron strip. Nut and bolt bars of English make are quoted £9 15s. This price is shaded for attractive lines, either in the matter of quantity or of such sizes as are suitable to the particular mills. Fencing iron commands £9 17s. 6d. The larger purchases of country customers, which have been in evidence recently, is attributed not only to a more active consumptive demand, but to the greater confidence which is felt in the stability of prices.

Galvanised Sheets Easier.

With the increased output of galvanised sheets market solidarity is not maintained. Some of the small manufacturers are not so well sold as their bigger competitors, and they are taking business down to £17 5s. The Welsh tin-plate makers have advanced their minimum by 6d., making it 19s. 9d. f.o.t. works; 3d. to 6d. above that figure is generally asked.

Steel Railway Sleepers.

It is understood in iron and steel circles in Birmingham that a firm of locomotive engineers at Stafford has received an order to supply nearly a quarter of a million of steel railway sleepers to the Indian Government. The firm has also in hand, it is stated, the construction of three locomotives for a foreign destination.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Outlook.

THE markets in Manchester, in all departments of the iron and metal trades, are steady and cheerful; and although there is not much business being done, there is more than has been the case for several months, and any lack of activity is generally attributed to the time of year. Consumers do not buy very freely after the middle of December, for the simple reason that they find it convenient to keep their supplies of material low in view of the near approach of stocktaking. Very optimistic opinions are now being expressed as to the prospects of trade next year; and it is perhaps as well to utter a word of warning in this connection. In all probability business will be more active, but it certainly does not follow that prices will improve as a consequence. When all the productive capacity of the country is well employed, an increase of business leads automatically to an increase of prices; but when fully half of this productive capacity is unemployed, then the increase of business leads first of all to an increase of production. Hence it would be premature to assume that we are on the eve of any serious rise in the prices of iron and metals. There is room for a very great expansion of business before the prices need be affected to any extent. It is, however, possible that there will be less of the unprofitable production which has been a feature of the iron and steel trades for so long a time.

Metals.

In the copper market there has been a slightly better feeling, so far as standard copper is concerned, but practically no change in refined copper. Any small rise in the electrolytic copper is, of course, counteracted by the rise in sterling in terms of dollars. There seems to be a prospect of a return to the par of Exchange with America during the next few months, and this must be accepted as a sign that Great Britain is rapidly recovering her old financial position in the markets of the world. There are now reports from America to the effect that South America is rapidly regaining its importance as a contributor of copper to the world's supply of that metal; and this may perhaps be taken as an indication that there will be plenty of copper to meet any likely expansion in consumption. It is highly important to the engineering trades of the country that they should be able to obtain cheap copper, although cheap refined and raw copper is not of so much use to these trades if they have to pay extravagant prices for manufactured metals. The rather large quantities of old metals which have been exported to the Continent during the last six months have had some effect in reducing the excessive supplies, and there is now a distinct tendency to a rise in the prices of scrap gun-metal and yellow brass. It is not clear why the continental markets have been allowed to make use of these very cheap alloys while in Great Britain they have been neglected; but the markets seem to have been strengthened by the removal of this surplus of scrap. The tin market has recovered from the recent set-back, and we now hear again of the possibility of much higher prices for tin. No doubt many of the weaker speculators have been shaken off by the drop, and it is possible that another rise is being engineered. If this comes about, however, it will again bring out more of the reserved stocks of tin in the East, and may again be checked. The general position in lead and spelter is not much altered. Lead has been rather firmer, and there is no indication yet that any collapse is near at hand. On the contrary, there are rumours of a renewal of the coal strike in Australia, which will again restrict supplies. The demand for spelter keeps good, and there has been no further expansion in the supply. The English makers appear to be very well sold.

Pig Iron.

The market in Manchester for foundry pig iron is much the same as it was. The attempt on the part of some of the makers to obtain a little more money from Manchester ironfounders does not seem to have met with much success; apparently the consumers who are affected are mainly those who want to buy small lots of 20 to 50 tons for immediate use. It is still possible to buy No. 3 iron for forward delivery well into next year at 90s. per ton delivered in Manchester. Sellers seem to be fairly well satisfied with the amount of the demand, but, of course, the supplies of foundry iron suitable for sale in this district are very much less than they used to be. Cleveland iron is reported weaker by 6d. to 1s. per ton, but this does not concern Manchester buyers to any extent. Hematite, on the other hand, is rather firmer than it was; but still cheap when compared with Cleveland and Scotch pig iron.

Finished Material.

There is said to be considerable improvement in the market for finished steel, but here one does not feel the effect to any great extent. Manchester may, however, be lagging behind the other districts; or, on the other hand, these reports may be exaggerated. There has been a little more buying of sectional steel, and there is an expectation of more activity in boiler-plate steel. This section of the trade may pay fair profits, but there is no profit on ordinary plates and sections unless prices can be put up to a large extent, or costs can be brought down. The latter is really the only safe way to bring about a condition by which the steel trade can again earn dividends.

Scrap.

An improvement in the markets for scrap may be admitted without qualification. Prices had been depressed far too much, and an advance would not do anybody any harm. Wrought scrap is fairly firm again at 70s. per ton delivered and heavy steel scrap is being inquired for. There does not seem to be a large supply of either sort. There is, however, a better supply of cast scrap, but even here some increase in the buying has to be noted; and dealers are inclined to ask rather more money.

Salford Electrical Engineer Appointment.

The Salford Electricity Committee has unanimously recommended the appointment of Mr. S. J. Watson, M. Inst. C.E., M.I.E.E., electrical engineer to the Bury Corporation, as electrical engineer to the Salford Corporation. The salary is £1250 per annum and bonus. There were originally fifty applicants for the post, and these were eventually reduced to five. Mr. Watson was appointed electrical engineer to the Bury Corporation in 1896, and since then he has been responsible for the erection of the power station which supplies Bury and the neighbouring towns, Heywood and Radcliffe. Mr. Watson was one of the three engineers who drew up the South-East Lancashire electricity scheme, which is now before the Electricity Commissioners. The appointment will require to be ratified by the Salford Council in January.

The Safeguarding of Industries Act.

In view of the differences of opinion which exist

with regard to the above-named Act of Parliament, the Manchester Chamber of Commerce has decided, on the suggestion of Sir Edwin Stockton, to take a referendum of the entire membership on the two questions: "Are you in favour of the repeal of the Safeguarding of Industries Act?" and "Are you in favour of the repeal of the Dyestuffs Act?" The result of the referendum will be awaited with considerable interest.

BARROW-IN-FURNESS, Thursday.

Hematite.

There is a further improvement to report in the hematite pig iron trade which can now be said to have thoroughly developed. In order to cope with the present demand, there has been another increase in the number of furnaces in blast. The Barrow works have put another in this week. The business in futures is improving, and orders are placed for delivery well into next year. America has taken other deliveries of pig iron, which have gone to Baltimore and Philadelphia (two cargoes). Scotland has become a good customer, and there are heavy deliveries to the Midlands. The business being done in better qualities of low phosphorus iron is improving. Manganese is finding a good market both at home and abroad.

Iron Ore.

The iron ore trade is improving and the demand on local account promises to be satisfactory. A fair amount is being sent away by rail and steamer. The better iron trade is gradually reducing the stocks of foreign ore at the docks, and in the meantime imports are being kept down to the minimum.

Steel.

The steel trade is dull at the moment, but there is a better tone about, and it is hoped that the rail mills will start on home and colonial account in the New Year. There has been a shipment of rails from Barrow during the week, but these were rolled some time ago. Foundries are experiencing better trade, and the hoop mills are still at work on orders.

Shipbuilding and Engineering.

A better complexion is put on trade by the securing of an order by Messrs. Vickers for the guns and mountings for one of the battleships. This will entail a considerable amount of work, and there is every prospect that the local naval construction works will enter on to a period of greater activity than has obtained for some time.

SHEFFIELD.

(From our own Correspondent.)

Sheffield and Naval Work.

THE outstanding item of news of the week relates to the placing of the long-expected naval orders. Sheffield has watched with great concern the Government delay in dealing with this matter, and as we approached the end of the year—by which time the two new battleships must be laid down, if at all—and silence was still maintained, considerable apprehension was felt. However, the matter has been decided now, and the publication of the various items of news in connection with it has come with gratifying promptness. On Monday the Prime Minister stated in the House of Commons that it had been decided to lay down the vessels, and on Tuesday it was announced that the order for the hull and machinery of one of the ships had been given to the Sheffield and Birkenhead firm of Cammell Laird and Co., that Sheffield would share in the manufacture of the armour plate and guns, and that some of the gun mountings would be made at Barrow. Needless to say, Sheffield is pleased with the decision of the Government. Its armament departments have had a very lean time for several years, and have suffered many disappointments, the greatest of them being the cancelling of the orders for the four warships which were given out a year ago. The two ships now to be built will not compensate for that loss, but they will do something to help. It is not only the armament shops that benefit from the building of warships. A great deal of engineering work is involved in the construction of the machinery, and there is a large call for all kinds of engineers' tools, the makers of which are by no means well off for work at present. The effect of the placing of the orders will, of course, be gradual. There will be no great rush of new work, and it will probably be some months before activity on the new construction reaches its apex. Even from the beginning, however, some benefit will be felt, and the new ships will do something to accelerate that gradual decrease of unemployment which has now set in. The number of names on the unemployment registers fell last week by nearly 600, but the total still remains at the high figure of 36,420.

Railway and Shipping Orders.

A very useful order which has come the way of Cammell Laird and Co., Limited, this week is for three small lake steamers for Canada, each of 2500 tons deadweight capacity. The railway steel and electrical branches are now pretty well employed. Makers of railway tires, axles and springs are finding work come forward at an increasing pace. A number of large orders have been placed, and others are regarded as certain. Home railway requirements are on an enormous scale, in addition to which work is coming from India, and there is a prospect of quite a boom in these departments in the spring. One firm has a large new shop ready to start on the manufacture of laminated springs, and is looking for greatly increased activity in this branch.

Heavy Steel Progress Continued.

The improvement in the heavy steel trade is well maintained. The demands on the open-hearth furnaces show advances week by week, and production is now above the pre-war average. There are still many idle furnaces, owing to the capacity of the city having been so greatly increased, but the new battleship orders will do much to absorb these. Semi-manufactured steel is by no means too easy to get hold of at present, and prices are stiffening. Hard basic billets went up 10s. a fortnight ago, and the soft qualities have now followed suit, while steel hoops have risen by 5s. a ton. The lighter side of the steel trade, however, is not doing so well. There is still a good deal of slackness in the high-speed steel, crucible steel, engineers' small tools, engineering, steel springs, wire, iron and steel castings and other branches. Most of them, however, show signs of improvement, and have on hand inquiries which should result in work at an early date. Some firms of steel casting makers which have been very poorly employed throughout the year have recently received several satisfactory orders. The wire rope makers are receiving more orders, and common wire sells well, but for high-grade wire there is a poor demand. There is much variation in the conditions at the tool works, and a busy week is often followed by a slack one. While circular saws are in moderate request, the trade in small saws is much less satisfactory.

Cutlery and Plate.

There is still a large amount of activity in these old-established trades, although it is not evenly distributed. Quite a number of firms complain that they have had a poor season. Most of them, however, are well employed, and although the Christmas demand is quietening down in some cases, others have the prospect of very full work for another fortnight. In the table knife department, stainless steel is almost universally specified, and its popularity seems to be still increasing. There is but a slow demand for pen and pocket cutlery, but there are arrears of orders which are keeping some of the works fairly busy. On the electro-plate side, the demand is principally for the cheaper classes of goods, but the trade in best silver and plate and in cabinets and cases of plate and cutlery has been better than was anticipated. Trade with the overseas parts of the Empire keeps at a good level, especially with Australia, where there is a very good demand for spoons and forks of the new stain-resisting nickel alloy. The Britannia metalware branch is still well employed, and has arrears of orders to work off.

Electrical Items.

The inquiry of the Electricity Commissioners into the scheme for constituting a Joint Electricity Authority for the North-East Midlands District was concluded during the past week. It has been a protracted affair, in which many public and private undertakings have been represented, and the evidence given has foreshadowed great developments in the use of electricity in the district. A point of interest is that the Sheffield Corporation, which recently adopted a new system of refuse disposal, is converting the bulk of its transport vehicles in connection with this work for electrical propulsion. The number of such vehicles is being greatly increased, and there are now fifty-four of them. In order to accommodate them, it is necessary to build a new garage, and a Ministry of Health inquiry has been held into an application for sanction to the borrowing of £30,000 for this purpose. The Corporation has also decided to proceed with the work of extending the mains between Renton-street and Hunter's Bar sub-stations and between Ellin-street sub-station and Canterbury-lane, Fulwood, for increasing the supply for tramway purposes and for general distribution purposes, at an estimated cost of £12,390. Further, there is to be an extension of the mains to afford a supply of electricity to Handsworth and Woodhouse by means of overhead transmission lines, at an estimated cost of £11,088, and tenders for the construction of the whole of the overhead work are to be invited.

Cheaper Houses at Doncaster.

An instance of the way in which the cost of house building has come down during the last year or two is afforded by the experience of the Doncaster Corporation, which has just accepted tenders for the building of two lots of houses on its Carr House-road site. One group, consisting of twenty houses, is to be erected by Mr. J. H. Elsom, of Doncaster, for £7816. The other contractors are Forsdike, Limited, of Sheffield, who are to build fifty-four houses—twelve of them for £3900, four for £1368, twelve for £3942, ten for £4140, and sixteen for £6352. Alderman Theobald said that the tenders accepted were the lowest. The non-parlour house had come down to £325, whereas when the Corporation started to build the cost reached £810 in one case.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Outlook.

CONFIDENCE in the trade outlook in the North of England is becoming more pronounced, and an expansion of operations in most departments of industry is expected after the holidays. At the moment business in almost every direction is extremely quiet, but this is the usual experience when approaching a holiday period. It is merely a passing phase, and it is confidently expected that with the turn of the year trading will be resumed on a considerably broader basis than heretofore.

Cleveland Iron Trade.

The Cleveland pig iron market has assumed a much quieter appearance. A few orders for small quantities continue to come forward, but for the most part consumers appear to have covered their requirements up to the end of the year and show little disposition to place forward business. The export trade is also falling off. Thus the output—at least of foundry iron—exceeds the demand, and some of the makers are prepared to cut prices if suitable business is offered. There is at the moment a good deal of irregularity about prices. Some of the makers are not inclined to follow the downward trend, and there is a good deal of solid ground for the view that the present falling off in the demand is quite temporary, and that the turn of the year will see a big increase in business. On the other hand, some of the makers are anxious to avoid accumulating stocks and are offering some cheap iron. An average quotation for No. 3 G.M.B. Cleveland pig iron is now no more than 91s. Even that price is reported to have been shaded. No. 1 is about 95s.; No. 4 foundry, 87s.; No. 4 forge, 82s. 6d.; and mottled and white, 80s. to 81s. per ton.

Hematite Pig Iron.

There is no corresponding weakness in the East Coast hematite pig iron trade. On the contrary, business continues brisk and the output is well taken up. Several makers are well sold into next year, but other firms are not quite so favourably placed and are still prepared to grant slight price concessions on the recognised market rates. Mixed numbers are put at 93s. per ton, with No. 1 at a 6d. premium.

Iron-making Materials.

Little new business is reported in the foreign ore trade. Deliveries recently have been somewhat heavy, and as all immediate needs are covered consumers show a disposition to use up their stocks before entering into further commitments. Nevertheless, sellers are not showing any weakness. On the contrary, prices are a little firmer, and 22s. is now the general quotation for best Rubio ore. The coke market is also strong, and 29s. per ton is quite a minimum price for medium furnace kinds delivered at the works.

Manufactured Iron and Steel.

The healthier tone of the manufactured iron and steel trade is still maintained. Inquiries are more numerous and a steady improvement is noted in most branches of the industry. Recognising that no advantage is to be gained by waiting, buyers are now placing orders more freely. Prices are unchanged.

Foreign Competition.

Keen foreign competition has resulted in the loss of another important ship-repairing contract to the Tyne. A Norwegian vessel was brought to the river and docked for survey, but when tenders were invited for the necessary repairs the figures quoted by a Rotterdam firm were so low that it was impossible to compete against them, and consequently the work was transferred to the Continent. A Tyneside firm, however, has been successful in securing a contract to execute repairs to a vessel which is at present at Antwerp, although tenders were received from Belgian and other continental firms.

The Coal Trade.

The Northern coal trade on the whole is distinctly quieter. The tone of the market, however, remains firm and assured for any period of shipment this side of April. Though there may be easy patches revealed here and there for second Durham classes, it is merely a case of dislocation at the spouts, and is due to a shortage of wagons to enable the output to be cleared. So far as this month is concerned there are only odd parcels for disposal, the collieries in every case being well sold forward. There are many complaints with regard to the congestion at the staiths and docks. Strings of steamers are kept lying for days awaiting cargoes and incurring heavy demurrage charges to the shippers, as well as causing confusion and loss of time at the pits. This, however, it is hoped, will now be gradually worked off when the three-shift system is in full operation. There is not much new business being placed for shipment abroad. Most of the continental buyers, including Germany, are inclined to hold off for the present in the hope probably that the rate of exchange will again move in their favour, and also that the high prices ruling here may ease down. At the same time exporting merchants continue to probe the market by circulating inquiries in order to be able to take advantage of a possible opening on favourable terms. So far as appearances go, the outlook for the first quarter of next year is in the direction of firmness. Many of the collieries in both counties are already well sold for that period and look askance at anything below the current quotations, preferring to await developments before committing themselves further. All classes of Northumberland steam coals are well inquired for. Best and second screened sorts are particularly well placed, while smalls are also improving. Special and prime gas coals are exceedingly scarce and very firm, while secondary classes are also in a good position for a while ahead. Coking coals are scarce and firm for any date of loading. Coke is more plentiful in the case of patent oven, which is a trifle easier. Gas coke is moderately steady and unchanged in price.

SCOTLAND.

(From our own Correspondent.)

Brightening Outlook.

ALTHOUGH there is not likely to be any perceptible change in the volume of business during the remainder of the present year, indications point to much greater activity within a few weeks. Apart from recent shipbuilding orders, the number of which is still being added to, business is opening up in various directions. The opinion is now more generally held that prices are practically at the lowest level possible. Work which recently would surely have gone to the continental makers is being diverted to home works, and producers seem to be on the point of reaping some reward for their efforts to meet the needs of the times. The revival in the shipbuilding industry has exceeded immediate expectations, and busy conditions are promised in Greenock and Port Glasgow, and

perhaps to a lesser degree on the upper reaches of the Clyde. Cargo vessels are now more prominent, and the orders are being well spread over such centres as Ardrossan, Leith and Burntisland.

Glasgow Buys English Rails.

The Glasgow Corporation Tramways Committee has accepted an offer from the Cargo Fleet Iron Company, Middlesbrough, for the supply of 4200 tons of steel rails, at a cost of £41,000. A similar tender from Germany was £5000 cheaper, and one from Belgium £4000 below the British estimate.

New Road between Edinburgh and Glasgow.

A big scheme to construct a new road giving direct communication between Edinburgh and Glasgow is under consideration by the Corporations of both cities. The scheme is on similar lines to the Liverpool and Manchester project, which is to cost £3,000,000. Government assistance also would be expected for the Scottish scheme. The work in prospect would give employment to about 10,000 men for two years, and would greatly cheapen motor transport between the two cities.

Record Discharge of Grain.

A record discharge of grain was carried out at Glasgow Harbour last week through the employment of the additional new suction plant provided by the Trustees, and constructed by Henry Simon, Limited. A Greek steamer from the River Plate, carrying 6036 tons of grain, was discharged in thirty hours actual work, an average of 200 tons per hour.

Steel and Iron.

As already mentioned, although actual business at the steel works is still of small bulk, reports of fresh orders in circulation are more numerous, and a much more hopeful feeling exists. The railway companies are assisting by a reduction in rates. In any case local makers are now meeting with more success in competition with continental producers, even though the latters' prices are a little more favourable. Home makers are now evidently better able to give delivery within a reasonable period. Meantime boiler and ship plates are not very active, and sheets are in active request only in the thinner gauges. Bar iron makers have better prospects, while the steel departments continue to improve. The home demand for bars and strips has increased considerably of late, the latter especially so, owing to better conditions in the tube trade. Business in the pig iron trade has become very slow. Exports have fallen away and home demands are still meagre. Little or no inquiry is received for either hematite or foundry.

Coal.

Shipments of coal from Scottish ports have made a good recovery, and the aggregate returns for the week amounted to 331,689 tons, against 268,536 in the preceding week, and 274,175 tons in the same week in 1913. The collieries in the various districts are well booked up for round coal and treble nuts, and supplies of these are only now available in small lots through second-hand sources. Double nuts are busier, but smaller descriptions are rather neglected. Serious congestion is still reported from east of Scotland ports, and especially in the Fifeshire area. Not only are exporters becoming liable for severe demurrage charges, but the tying up of loaded wagons has caused a great shortage of empties, and may force a restriction in output. The home demands for fuel are not satisfactory. Regular deliveries are going to gas and electricity works and railways, but the industrial and household turnover is below normal, the former particularly so. An easier tendency is noticeable in prices, but so far the export quotations are nominally firm, and show practically no change from the preceding week.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

COLLIERY salesmen have been encouraged more than ever during the past week or so to adopt optimistic views regarding the prospects of business over next year, and particularly as regards the first six months, and, as a consequence, they are advancing their prices. Current values of best Admiralty large are round about 29s. 6d. to 30s., and business has been done at the higher figure, while for supplies for delivery over the whole of 1923 salesmen are now pretty firm at 27s. to 27s. 6d. Although the conditions as regards new business are at the moment a trifle slow, attributable to the fact that exporters are not keen to accept fresh commitments for shipment this month, and also to the fact that coals are very tightly stemmed, the market is very firm, and collieries have sufficient orders on their books to carry them well into January. The Central Argentine Railways are credited with having bought from 200,000 to 250,000 tons of second Admiralty and superior Monmouthshire large coals at the price of round about 26s. for delivery over next year, and there are inquiries on the market from French railways for a quantity aggregating about 40,000 to 50,000 tons of large and a similar quantity of small coals, for delivery over the next three months. Middlemen are also showing more disposition to fix up arrangements with the collieries for supplies ahead, and rumours are current of a fair quantity of steam coals from this district having been sold for shipment to the northern range of American ports.

Dock Charges.

The announcement was made towards the end of last week that as the result of a conference between Mr. Felix Pole, the general manager of the Great Western Railway, and the sub-committee appointed by the traders, with reference to future reductions in dock charges, an agreement was arrived at, the particulars of which are to be announced this week. At the moment of writing the details are not available, but the fact that agreement has been reached is of great importance, as it means that trade will be assisted and the concessions which have presumably been granted will result in the traders not proceeding with their objection to the application put forward by the Great Western Company to the Rates Advisory Committee for the continuance of the present charges.

Dock Working Conditions.

So far the Great Western Company and the coalowners have not made the progress that was hoped for and desired on the question of revised working conditions at the South Wales docks. The opinion is now pretty well held by everyone except labour that the remedy for the present congestion and the facilitating of trade is the adoption of the third shift, thus re-establishing pre-war conditions, but labour has yet to be convinced of the efficacy of the remedy, and notwithstanding that such a proposal would mean extra employment, the leaders appear to be in no hurry even to discuss the matter. In order that the public should be acquainted with the position and fully understand where lies the responsibility, the secretary of the Coalowners' Association has published correspondence which has passed between Mr. J. H. Vickery, the chief docks manager of the Great Western Railway Company, and himself and the general secretary of the National Transport Workers' Federation—Mr. Bevin. The latter was asked to arrange for a conference to discuss the working conditions, but the reply was simply a request to be furnished with the statistical and other information on which the Great Western Company and the coalowners relied to arrive at their decision that an extension of working hours was desirable. As the result of a further letter, the general secretary of the Transport Workers' Federation replied that "we are consulting our people on the whole position," and that is how the matter stands at present. The secretary of the Coalowners' Association states that the men's reply involves a regrettable departure from the established custom of the coal trade. That custom is that whenever a matter of common interest is raised by either the miners or the employers, and a request is made by either for a joint conference to consider it, that conference is almost immediately held. The secretary of the coalowners can recall no occasion during the past thirty years when that custom has been violated.

New Works.

The report is current that Cardiff is likely before long to be selected as the site of new large flour mills by one of the largest undertakings in this line in the country. As is well known, Messrs. Spillers have large mills and works at the Cardiff docks, and Messrs. Rank have similar works at Barry Dock. It is understood that the firm contemplating coming to this city is very favourably impressed with the many advantages of this port, and there is no doubt that the Great Western Railway Company will offer the best facilities possible. Until the scheme becomes absolutely definite, the name of the firm interested is withheld.

Steel Bars.

The South Wales Siemens Steel Association has decided to make no alteration in the price of steel bars until the end of the year, but it is expected that in January the price will be raised by 3s. 9d., making the minimum £7 13s. 9d. per ton, less rebate. It is also regarded as certain that the minimum price of tin-plates will be put up from 19s. 6d. to 20s. per box at the same time.

Current Business.

Actual business for supplies of steam coals for anything like early shipment has been on a negligible scale during the past week, and is likely to continue to be the case until the new year comes in. The fact is that collieries are very hard pressed to execute their existing commitments, and the docks are so congested that anyone who takes on fresh orders for loading during the next three weeks is likely to meet with more trouble than the business is probably worth. The tone of steam coals all round is very firm, and 30s. is quoted in some places for best Admiralty large, and, in fact, has been done, while best small coals range up to 19s. Coke is strong, and patent fuel is better, works being more comfortably stemmed than for some weeks past. In the case of anthracite coals, the market is on the easy side, except in the case of beans and pea nuts and rubbly culm and duff coals.

Latest News from the Provinces.

LANCASHIRE.

BARROW-IN-FURNESS.

Steel Departments Restarting.

THERE will be increased activity industrially in the steel trade at Barrow next week. Notices have been posted stating that the Siemens department and the rail mills will restart on Monday. They have been idle for several weeks.

WALES AND ADJOINING COUNTIES.

Miners' Holidays.

The official holidays in the South Wales coalfield this Christmas time will be confined to Christmas Day and Boxing Day instead of the usual three days.

Dock Charges.

The agreement come to between the Great Western Railway Company and the representatives of the General Committee of Traders, states that, provided the latter and the Associations they represent do not oppose the application of the Great Western to the Minister of Transport, and provided the average weekly tonnage shipped and discharged at the South Wales ports during the three months ending December, 1922—excluding Christmas week—approximates in volume to the average weekly traffic for the first two weeks of October, 1922, the Great Western Company will reduce as from January 1st, 1923, tonnage rates on vessels from 100 per cent. to 75 per cent. above the corresponding charges in operation at December, 1913, and tipping and weighing charges from 9d. to 8d. per ton.

Buxton Award.

Efforts to arrive at a settlement on differences respecting the Buxton award, having failed on the point affecting men employed on the Sunday night shift at collieries where it has been the custom for the whole of the men to work that shift, it has been arranged to refer the matter to Lord Buxton.

LAUNCHES AND TRIAL TRIPS.

ADDA, twin-screw passenger liner; built by Harland and Wolff, Limited; to the order of Elder, Dempster and Co., Limited; dimensions, 450ft. by 57ft. by 34ft. 6in.; to carry 7800 gross tonnage. Engines, two eight-cylinder four-cycle Diesel oil, pressure 6000 indicated horse-power; trial trip, November 14th.

SAN MACEDONIO, oil tank steamer; built by Palmers Shipbuilding and Iron Company; to the order of the Eagle Oil Transport Company; dimensions, 422ft. by 52ft. 4in. by 31ft. 6in.; to carry 8250 tons deadweight. Engines, triple-expansion, 27½in., 46in., 77in. by 48in. stroke, pressure 180 lb.; constructed by the builders; trial trip, November 14th.

BRITISH OFFICER, geared turbine oil tank steamer; built by Palmers Shipbuilding and Iron Company, Limited; to the order of the British Tanker Company, Limited; dimensions, 440ft. by 57ft. by 33ft. 11in.; to carry 10,200 tons deadweight. Engines, single-screw double-reduction geared turbines, pressure 200 lb.; constructed by the builders; trial trip, November 16th.

BRITISH CAPTAIN, geared turbine oil tank steamer; built by Palmers Shipbuilding and Iron Company; to the order of the British Tanker Company, Limited; dimensions, 440ft. by 57ft. by 33ft. 11in.; to carry 10,200 tons deadweight. Engines, single-screw double-reduction geared turbines, pressure 200 lb.; constructed by the builders; launch, November 17th.

AVRISTAN, steamer; built by Wm. Gray and Co., Limited; to the order of F. C. Strick and Co., Limited; dimensions, 362ft. 9in. by 52ft. 6in. by 29ft. 4½in.; to carry 6900 tons. Engines, triple-expansion, 26in., 42in., 70in. by 48in. stroke, pressure 200 lb.; constructed by the builders; trial trip, November 18th.

CUBA, twin-screw steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of Compagnie Générale Transatlantique, Paris; dimensions, 495ft. by 62ft. by 38ft. Engines, two sets of turbines, Metropolitan-Vickers-Rateau type; constructed by the builders; launch, November 20th.

HOPPER BARGE NO. 26; built by the Monmouth Shipbuilding Company, Limited, to the order of the Port of London Authority; dimensions, 215ft. by 35ft. 6in. by 19ft. 3in.; trial trip, November 10th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE LEWIS SPRING COMPANY, Limited, Redditch, asks us to state that it has appointed Lionel Robinson and Co., of 3, Staple-inn, Holborn, W.C. 1, sole agents for the electrical trade for its products.

WE are asked to state that the address of the *Journal* of the American Institute of Architects has been changed to Fisk Building, 57th-street, Broadway, New York City, to which it is requested that all communications should now be addressed.

THE POWER ENGINEERING COMPANY, Limited, of Trafford Park, Manchester, inform us that it has taken over the British agency for the U.S. Smelting Furnace Company, of Belleville, Ill., makers of rotary furnaces for smelting non-ferrous metals and enamels, from Enamelware Equipment, Limited.

BRUCE PEEBLES AND CO., Limited, of Edinburgh, ask us to announce that their works will be closed for the New Year holidays from Friday, December 29th, 1922, until Monday, January 8th, 1923. No goods will be received or dispatched between these dates, and only urgent correspondence will be dealt with.

WE are informed that Mr. Percy N. Everett, Assoc. M. Inst. C.E., late chief Diesel engineer with Sir W. G. Armstrong, Whitworth and Co., Limited, Elswick Works, Newcastle, has now joined the staff of Hick, Hargreaves and Co., Limited, Soho Ironworks, Bolton, as manager of the latter firm's oil engine department.

NECOL INDUSTRIAL COLLODIONS, Limited, asks us to state that, owing to the necessity for its being nearer the parent concern—Nobel Industries, Limited—at Nobel House, it has taken new offices at Windsor House, Victoria-street, Westminster, S.W. 1, to which address all letters should be sent on and after December 18th.

THE LONDON ELECTRIC FIRM, Brighton-road, Croydon, informs us that it has purchased from Henry Williams, Limited, of Darlington, the branch of that firm's business recently trading as the Arc Lamp Lowering Gear Company (and formerly as the North-Western Appliances Company, of Cathcart, Glasgow), including the whole of the designs, patterns, entire stock, tools, jigs, drawings, patent rights and goodwill.

TUBE MAKING ON THE CINEMATOGRAPH.—At an informal meeting of the Institution of Mechanical Engineers, which was held at Storey's-gate on Friday, the 8th inst., Engineer-Captain J. A. Richards, R.N., exhibited a cinematograph film showing the manufacture of solid-drawn steel tubes in the works of Tubes, Limited, Birmingham. In introducing the film, Captain Richards gave a brief outline of the several processes employed in piercing billets preparatory to their being drawn down to tubes, and explained how the pilger process, which employs a pair of gapped rolls, got its name from the peculiar backwards and forwards step adopted by pilgrims to a continental shrine on ceremonial occasions. The film itself gave glimpses of most of the processes through which the tubes go, and was followed by some lantern slides of Victaulic pipe joints. Mr. Patchell, who was elected chairman for the meeting, made a few remarks on the relative merits of solid-drawn and welded tubes, and said that he had recently studied the manufacture of the latter on a large scale in America.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	22/6
(1) Spanish	22/6
(1) N. African	22/6
N.E. COAST—	
Native	—
Foreign (c.i.f.)	22/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 7 6	—
No. 1 Foundry	5 0 0	—
No. 3 Foundry	4 15 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 13 0	4 13 0
No. 1	4 13 6	4 13 6
Cleveland—		
No. 1	4 15 0	4 15 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 11 0	4 11 0
No. 4 Foundry	4 7 0	4 7 0
No. 4 Forge	4 2 6	4 2 6
Mottled	4 0 0 to 4 1 0	4 0 0 to 4 1 0
White	4 0 0 to 4 1 0	4 0 0 to 4 1 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	3 12 6	—
,, ,, Foundry	4 4 0	—
(3) Northampton—		
Foundry No. 3	4 0 0	—
,, Forge	3 10 0	—
(3) Derbyshire—		
No. 3 Foundry	4 2 6 to 4 3 6	
Forge	3 12 6	—
(3) Lincolnshire—		
Basic	4 0 0	—
Foundry	4 2 6	—
Forge	4 0 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 10 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 10 0	10 10 0
Best ,,	12 0 0	—
N.E. COAST—		
Crown Bars	10 10 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	18 15 0
S. YORKS.—		
Crown Bars	11 10 0	—
Best ,,	12 10 0	—
Hoops	14 0 0	—
MIDLANDS—		
Crown Bars	10 7 6 to 10 15 0	
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	9 12 6 to 9 15 0	
Gas Tube Strip	10 10 0 to 10 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	12 0 0	—
Ship Plates ½in. and up	8 15 0	—
Sections	8 7 6	—
Steel Sheets ⅛in. to ½in.	10 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	17 10 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	9 0 0 to 9 10 0	—
Angles	8 15 0 to 9 0 0	—
Boiler Plates	12 10 0	—
Joists	9 0 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0 to 14 0 0	
Channels	13 10 0	—
Hard Billets	8 15 0	—
Soft Billets	8 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light ,,	9 10 0 to 10 0 0	
Billets	8 10 0	—
MANCHESTER—		
Bars (Round)	9 0 0 to 9 10 0	
,, (others)	9 10 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	9 0 0 to 10 0	
,, (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	8 15 0	—
Soft ,,	7 10 0 to 7 15 0	
Hoops	11 15 0	—
Soft Wire Rods	10 0 0	—
MIDLANDS—		
Small Rolled Bars	8 15 0	—
Billets and Sheet-bars	7 2 6 to 7 5 0	
Gas Tube Strip	10 0 0 to 10 5 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	17 5 0 to 17 10 0	
Angles	8 15 0	—
Joists	8 15 0 to 9 0 0	
Tees	9 10 0 to 10 0 0	
Bridge and Tank Plates	9 0 0 to 9 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/1½
Block Tin (cash)	175 10 0
,, (three months)	176 15 0
Copper (cash)	62 10 0
,, (three months)	63 5 0
Spanish Lead (cash)	26 0 0
,, (three months)	25 2 6
Spelter (cash)	37 17 6
,, (three months)	34 17 6
MANCHESTER—	
Copper, Best Selected Ingots	£6 0 0
,, Electrolytic	70 0 0
,, Strong Sheets	96 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 2½
Lead, English	27 5 0
,, Foreign	26 0 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23	10/o
,, 6 p.c. to 8 p.c. ,,	£21 0 0	8/-
,, 8 p.c. to 10 p.c. ,,	£20 0 0	8/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£54 0 0	20/-
,, ,, 1 p.c. ,,	£64 0 0	22/6
,, ,, 0·75 p.c. carbon	£72 0 0	25/-
,, carbon free	1/7 per b.	
Metallic Chromium	4/9 per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£11 2 6 scale 5/- per unit	
,, ,, 75 p.c.	19 10 0 scale 6/- per unit	
,, Vanadium	17/- per lb.	
,, Molybdenum	9/6 per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£166	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

	Export.
SCOTLAND.	
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	24/-
,, ,, Ell	25/-
,, ,, Splint	25/6 to 28/-
,, ,, Trebles	24/-
,, ,, Doubles	22/-
,, ,, Singles	17/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	24/-
,, ,, Splint	25/6
,, ,, Trebles	24/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	22/6 to 25/6
Screened Navigation	28/-
Trebles	25/-
Doubles	22/6
Singles	18/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	24/6
Secondary Steam	23/9
Trebles	25/-
Doubles	22/6
Singles	18/6
ENGLAND.	
(8) N.W. COAST—	
Steams	29/6
Household	46/8 to 57/6
Coke	34/8
NORTHUMBERLAND—	
Best Steams	25/6 to 26/-
Second Steams	22/- to 23/-
Steam Smalls	12/6 to 14/6
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	24/- to 25/-
Second	22/- to 23/-
Household	25/- to 26/-
Foundry Coke	37/- to 40/-
SHEFFIELD—	**INLAND.**
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	24/- to 26/- —
,, ,, House	21/6 to 22/6 —
,, ,, Large Nuts	19/6 to 22/6 —
,, ,, Small ,,	15/- to 16/6 —
Yorkshire Hards	20/- to 21/- —
Derbyshire ,,	19/- to 20/6 —
Rough Slacks	9/- to 11/- —
Nutty ,,	7/9 to 9/9 —
Smalls	3 - to 5/- —
Blast Furnace Coke (Inland and Export)	21/- to 30/-
(9) SOUTH WALES.	
CARDIFF—	
Steam Coals:	
Best Smokeless Large	29/- to 30/-
Second ,, ,,	27/6 to 28/6
Best Dry Large	28/6 to 29/6
Ordinary Dry Large	27/6 to 28/6
Best Black Vein Large	27/6 to 28/-
Western Valley ,,	27/- to 27/6
Best Eastern Valley Large	27/- to 27/6
Ordinary ,, ,,	24/- to 26/-
Best Steam Smalls	18/- to 19/-
Ordinary ,,	15/- to 17/-
Washed Nuts	27/6 to 37/6
No. 3 Rhondda Large	29/- to 31/-
,, ,, Smalls	19/- to 21/-
No. 2 ,, Large	23/6 to 24/6
,, ,, Through	19/6 to 22/6
,, ,, Smalls	14/- to 15/-
Coke (export)	37/6 to 45/-
Patent Fuel	28/- to 30/-
Pitwood (ex ship)	33/- to 33/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	37/6 to 40/-
Seconds	30/- to 32/6
Red Vein	30/- to 32/6
Machine-made Cobbles	50/- to 52,6
Nuts	65/- to 67/6
Beans	42/6 to 45/-
Peas	22/- to 23/-
Breaker Duff	10,6 to 11/-
Rubbly Culm	14/- to 15/-
Steam Coals:	
Large	25/- to 26/-
Seconds	23/- to 25/-
Smalls	10/- to 12/-
Cargo Through	17/- to 20/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.
(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England (7) Export Prices—F.O.B. Glasgow.
(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export (9) Per ton f.o.b.

French Engineering Notes.

(*From our Correspondent in Paris.*)

The Situation

FOR some weeks past there have been signs of a general improvement in the engineering trades, and although the total amount of business is not considerable it is nevertheless sufficient to provide fairly regular employment amongst constructive engineers and machinery firms. A great deal continues to be done in the equipment of works and factories, not only in the devastated regions but elsewhere, and some good contracts have been secured for weaving machinery. The wagon building shops are better employed upon repairing rolling stock, and the distribution of new orders has partly relieved the anxiety that until recently hung over this branch of industry. Those customers who had been withholding orders in the belief that prices would come down are now giving them out in view of the tendency towards higher values. Manufacturers have been doing their best to keep prices down by agitating for advantages in the way of lower railway rates, but as the existing freights are to be maintained for a few months, and other charges are becoming heavier, makers find themselves with no alternative but to increase prices. The principal factor in the situation is the higher cost of raw material, which is due to the heavy purchases abroad at a time when the rate of exchange is against the buyer. All descriptions of pig iron and foundry iron are hardening, and it is regarded as quite probable that prices will be further advanced shortly.

Tariff Coefficients.

Certain changes in the coefficients applied to import duties are interesting as showing the tendency of the Government to resist the claims of manufacturers for greater protection until such time as the new fiscal Bill in introduced. The system of coefficients was supposed to be abolished at the end of this year, and preparations are already being made for the drawing up of a fiscal and trade programme which is to be presented to Parliament during the first half of next year. Meanwhile, a revised list of coefficients was completed some months ago, and was only held in abeyance on account of the opposition of manufacturing interests, which feared that in view of the continued depreciation of money values and of the increasing cost of production the home industries were not receiving sufficient support. The Government submitted the coefficients to the respective makers' Federations and invited their observations thereon. Apparently, in most cases, they are not convincing, for, while the new coefficients relating to some engineering and metallurgical products are still withheld, the others, published this week, have not shown any appreciable increase, and in some cases have even been reduced. On flour-milling machinery the coefficient has been increased from 3.2 to 4, but on spare parts for machinery it is reduced from 3.6 to 3.5. There is also a reduction of 7 to 5.7 on nuts, bolts, screws, &c., and on boiler work the reduction is from 2.9 to 2.8. On the whole, there have been small adjustments rather than big changes.

Electric Road Vehicles.

One of the most interesting developments in the general scheme of electrification which is being carried out actively all over the country is the possibility of current being supplied under conditions that will allow of electric vehicles being run more cheaply than with petrol. It is hardly likely that motor spirit will be superseded for touring cars, but if the system of national electrification, whereby current will be distributed throughout rural districts, allows of electrical energy being supplied at the low cost estimated, it is evident that for rural transport the electric vehicle may offer considerable advantages. It is already being employed to a certain extent for ploughing and for other farm work, and it is believed that with the provision of re-charging stations at suitable distances from each other all over the country there will be every inducement to employ lorries and other vehicles with storage batteries. The matter is regarded as so important that the Union des Syndicats de l'Eléctricité has, in conjunction with the French Automobile Club and the Chambre Syndicale des Constructeurs d'Automobile, decided to organise a series of official trials of all types of electric vehicles. The trials will be held in September of next year, and the competing vehicles will be exhibited at the following Paris Salon.

Alcohol Motor Fuels.

The Commission des Mines et de la Force Motrice of the Chamber of Deputies is endeavouring to give effect to the recommendation of the Liquid Fuel Congress held in Paris in October last by inquiring into the advisability of imposing upon oil importers the mixing of a certain percentage of alcohol with petrol as a motor fuel. It has been proved conclusively that a mixture of 10 per cent. alcohol can be employed under exactly the same conditions as petrol alone, and some official tests have even shown that the results are better. As the production of power alcohol is one-tenth the quantity of petrol imported the 10 per cent. mixture will represent so much saving to the country. The problem of dehydrating alcohol to prevent corrosion appears to have been overcome, and the only difficulty remaining to be settled is to conciliate the interests of alcohol producers and to regulate the price in such a way that the composite fuel will be cheaper than petrol. It is hoped to do this by means of Government control. Meanwhile, the State is offering dehydrated alcohol for mixing with petrol at what appears to be a very reasonable price.

Industrial Heating.

Arrangements for holding the Congress on Industrial Heating have now been completed. It will be held in June next at the Conservatoire des Arts et Métiers, and it is intended to organise an exhibition at the same time. An influential Committee has been formed, with M. Walckenaer as acting President.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

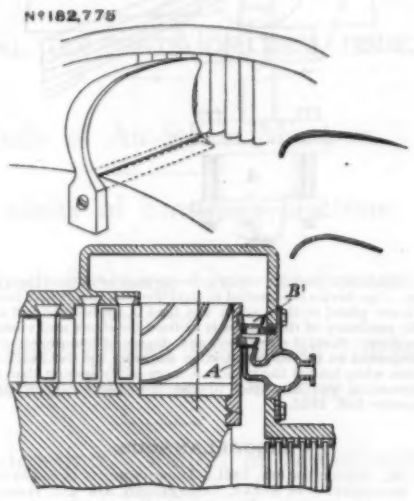
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TURBINE MACHINERY.

182,775. May 25th, 1922.—STEAM TURBINE BLADING, *The Metropolitan-Vickers Electrical Company, Limited, 4, Central-buildings, Westminster.*

IN this form of blading the last row of low-pressure blades receives the steam in an axial direction and discharges it radially. In this way, it is claimed, more area and a better discharge angle are obtained for the steam. The drawings show a perspective

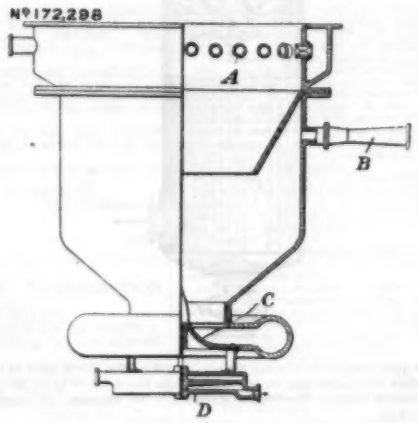


view and section through the special blading. An end plate A, which closes the ends of the blading, and thus ensures that the steam is discharged round the periphery, is used to carry the reverse blading B for going astern.—*November 9th*, 1922.

CONDENSERS AND FEED-WATER HEATERS.

172,298. November 28th, 1921.—JET CONDENSERS, *The Metropolitan-Vickers Electrical Company, Limited, 4, Central-buildings, Westminster.*

In order to reduce the height of jet condensers they are made in the form shown. The steam enters at the top and is met by

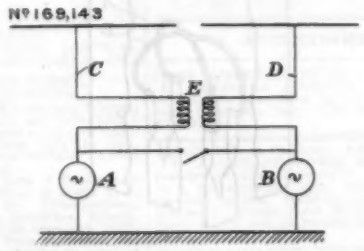


cooling water from the jets A. An air pump is connected at B. The extraction pump C is of the propeller type and is driven by an impulse steam turbine D.—*November 9th*, 1922.

TELEGRAPHS AND TELEPHONES.

169,143. June 3rd, 1921.—IMPROVEMENTS IN RADIO TELEGRAPHIC TRANSMITTING STATIONS, Joseph Bethenod, of 79, Boulevard Haussmann, Paris.

This invention relates to radio telegraphic transmitting stations employing a plurality of high-frequency generators,

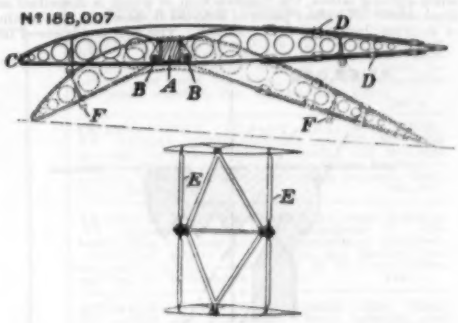


and its object is to permit either the simultaneous working of these generators at the same frequency so that the whole output may be supplied to the antenna or the independent working of the generators at different frequencies for multiplex transmission. The high-frequency generators A and B are connected respectively to the two sections C and D of the antenna and to earth. To prevent mutual induction, both electro-magnetic and electrostatic, between sections D and C a transformer E is provided.—*November 3rd*, 1922.

AERONAUTICS.

188,007. May 6th, 1921.—VARIABLE CAMBER AEROFOILS, F. P. H. Beadle, Flat 5, 54, Clarence-parade, Southsea.

The main spar of this wing is shown at A. To it are attached the forward and after parts of the wing by means of the hinges B B. The covering of the wing is of sheet metal or plywood and is securely attached to the framing at the forward edge C. The

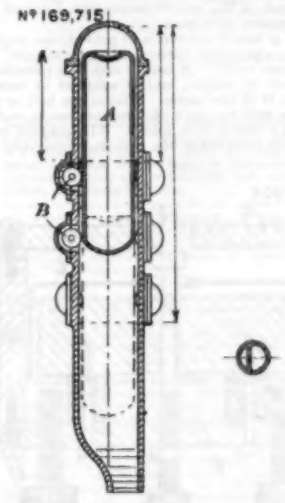


rear part is, however, free to slide on the framing, but is kept in place by lugs D passing through slots in the covering. The camber of the wing is varied by means of screw struts E E attached to lugs F F and operated by the pilot.—*November 6th*, 1922.

PUMPING AND BLOWING MACHINERY.

169,715. September 30th, 1921.—INTERNAL COMBUSTION PUMPS, H. Föttinger, 13, Bädeckerweg, Zoppot, Danzig.

This modification of the Humphrey pump is intended to minimise the loss of heat caused by the water being projected up into the hot products of combustion when the pump is worked

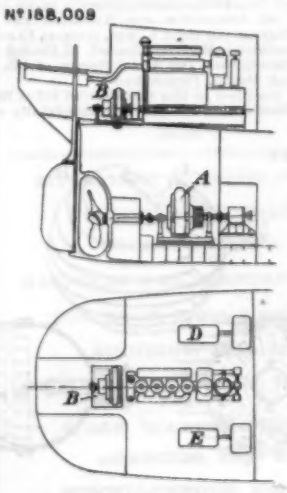


at a high speed. With this object a float A is arranged in the combustion chamber, from which it is separated by an annular space that becomes filled with inert gases. Rollers B B are provided to guide the float.—*November 9th*, 1922.

SHIPS AND BOATS.

188,009. March 13th, 1922.—ELECTRICALLY PROPELLED SHIPS, Robert MacGregor, of Sutherland House, Cumberland-place, Southampton.

This invention relates to electrical methods of propelling ships whereby as much space as possible in the ship is preserved



for cargo by installing the electric generating machinery for propelling purposes in the stern of the vessel. A represents an electric motor connected to the propeller shaft; B is a dynamo directly coupled to an internal combustion engine. D and E are

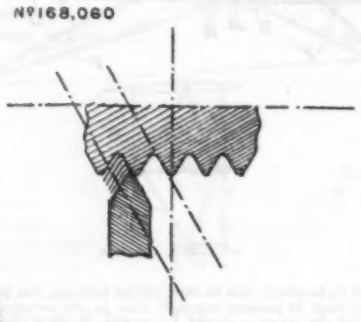
two auxiliary generating sets, each consisting of dynamo and internal combustion engine, which can be used separately for supplying the auxiliary services and also for running the electric motor A (or motors) for turning the propeller shaft with or without the main dynamo B and its engine. The dynamo and motors for propeller and auxiliary purposes are connected in the usual well-known manner by electric cables to a switchboard, from which the various units of the electric installation are controlled.—*November 9th*, 1922.

MACHINE TOOLS AND SHOP APPLIANCES.

168,060. August 17th, 1921.—SCREW-CUTTING LATHES, A. Bechler, Usines Mécaniques de la Condémine, Moutier, Switzerland.

This specification covers a special form of tool carriage for screw-cutting lathes, the construction of which is described and illustrated. The chief point of interest is, however, the method of working, indicated in the sketch. The tool is advanced into

N°168,060



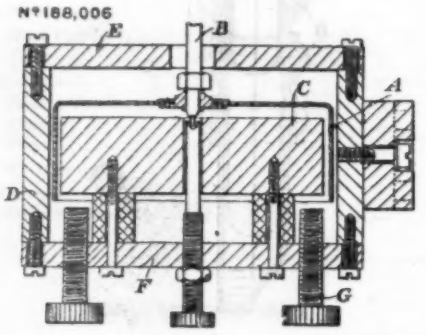
the cut in a direction parallel with one side of the thread, so that only one edge of the tool is cutting and can thus be ground to the best cutting angle. It is claimed that in this way fairly heavy cuts can be made and yet a good finish obtained.—*November 9th*, 1922.

MEASURING AND TESTING INSTRUMENTS.

188,006. May 2nd, 1921.—IMPROVEMENTS IN AND RELATING TO ELECTRICITY METERS, Frank Holden, of 34, Frognal, Hampstead, N.W., and Measurement, Limited, of 34 to 38, Provost-street, City-road.

The object of this invention is to provide an improved braking device for electricity meters, as, for example, in the well-known Thomson meter. A bell or cup A is provided, having a cylindrical wall of copper, and is adapted to rotate with the motor spindle B of the meter. Within the bell or cup is a bar magnet C of a steel having a high retentiveness, such as some of the well-known cobalt iron alloys. The magnet with the surrounding bell is situated in the chamber formed by a ring D of

N°188,006



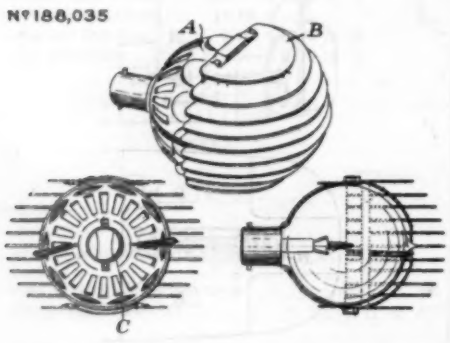
soft iron or other good magnetic material arranged to close the magnetic circuit. E and F are soft iron end plates. In order to provide for the variation in the braking effect means are provided for varying the strength of the magnetic field which is cut by the cylindrical wall of the bell. Some of the magnetic lines of force may, for example, be shunted to a greater or less extent by means of one or more screws G of magnetic material passing through one of the end plates and adapted to be moved into or withdrawn from proximity to the bar magnet.—*November 2nd*, 1922.

MOTOR CARS AND ROAD TRAFFIC.

188,035. April 1st, 1922.—IMPROVEMENTS IN OR RELATING TO DEVICES OR APPARATUS FOR AVOIDING THE GLARE OR DAZZLE EMANATING FROM LAMPS, SUCH AS ELECTRIC LAMPS OF AUTOMOBILES, Butlers, Limited, of Grange-road, Small Heath, Birmingham, and Alfred Reeves, of 133, Somerville-road, Small Heath, Birmingham.

The device described in this specification takes the form of a sheet metal shell which encloses or substantially encloses the

N°188,035

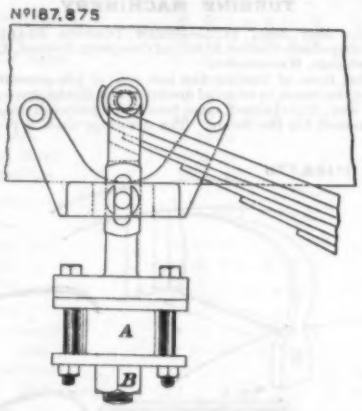


bulb and so breaks up the light. This shell is in the form of two more or less semi-spherical sections A and B, which may be separated by a circumferential band of light arranged in a plane transversely to the direction in which the lamp is adapted to throw its beam. The rear section of the shell may have a perforation C through which the base plug of the lamp passes.—*October 26th*, 1922.

187,875. December 3rd, 1921.—AN IMPROVED SHOCK ABSORBER FOR ROAD VEHICLES, William Moon, of 2, Belgrave-crescent, Edinburgh; William George Martin, of the North British Rubber Company, Limited; and the North British Rubber Company, Limited, of Castle Mills, Fountain.

A rubber disc A is clamped between a pair of compression plates by clamping bolts which pass outside the disc, the compression plates being supported by a shackle and bolt which are connected to the vehicle and to the end of the spring respectively or *vice versâ*. In this manner vertical relative movement between the end of the spring and the vehicle is absorbed or minimised by the rubber disc, which is compressed under the vibrations of

N°187,875



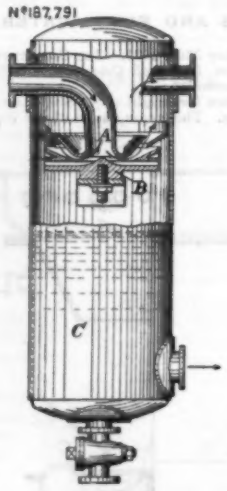
the vehicle and thereby tends to neutralise or absorb the vibrations. The device is adjusted so that the lock-nut B just touches the lower plate, so that when the load is applied the full effect of the resiliency of the rubber is utilised for shock and vibration absorption; but, if necessary, any degree of compression may be imparted to the rubber disc by screwing up the lock-nut B so that when loaded the vehicle is more stiffly sprung than if no compression was imparted to the untouched rubber disc.—*November 2nd*, 1922.

MISCELLANEOUS.

187,791. September 8th, 1921.—IMPROVEMENTS IN SEPARATING APPARATUS FOR STEAM, COMPRESSED AIR AND GASES OF ALL KINDS, Oskar Loss, of 86, Kaiserin Augusta Allee, Charlottenburg, Germany, and David Grove Aktiengesellschaft, of 86, Kaiserin Augusta Allee, Charlottenburg Germany.

The steam in the pipe A is made to spread out in an annular nozzle, and all heavy substances carried along by the steam are thrown by the pressure upon the deflecting surface B, the solid

N°187,791

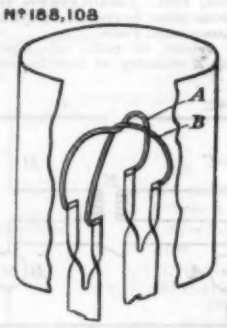


and liquid substances being accumulated in the lower part of the chamber C, whilst the steam which has been freed from heavy substances follows the course shown by the arrows.—*November 2nd*, 1922.

188,108. August 23rd, 1921.—IMPROVEMENTS IN ELECTRON DISCHARGE DEVICES, The General Electric Company, Magnet House, Kingsway, W.C. 2, and Brian Stephen Gossling, of the Research Laboratories of the General Electric Company, Brook Green, Hammersmith.

This invention relates to an electron discharge device having as a cathode a filament system comprising at least two loops A and B, so arranged that the stability of the filament-anode system

N°188,108



is maintained without the use of an auxiliary tensioning device even in a powerful electrostatic field. The invention is claimed to be especially applicable to thermionic rectifiers operating at high voltages.—*November 9th*, 1922.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

THE JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecturette: "Notes on Printing Machinery," by Mr. W. T. Marchment (slides). 7.30 p.m.

THE INSTITUTION OF PRODUCTION ENGINEERS.—The Engineers' Club, Coventry-street, W. 1. Paper: "The Production Engineer," by Mr. H. E. Honor. 7.30 p.m.

THE INSTITUTION OF AERONAUTICAL ENGINEERS.—The Engineers' Club, Coventry-street, W. 1. Paper: "Experimental Data without Wind Channel," by Mr. O. T. Gnosspelius. 6.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Literary and Philosophical Society, Newcastle-on-Tyne. "Wireless Broadcasting and its Possibilities," by Mr. A. P. M. Fleming. 7.30 p.m.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, S.W. Paper: "Reclamation Plant and its Operation," by Gascoigne Lumley. 6 p.m.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS: SCOTTISH CENTRE.—Royal Technical College, George-street, Glasgow. Paper, "Impressions of Modern Locomotive Design, with Observations on their Performance on the Road," by Mr. J. M'Coll. 7.30 p.m.

SATURDAY, DECEMBER 16TH.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—Visit of the London Graduates to the aluminium foundry of Mr. R. W. Coan, 219, Goswell-road, E.C. 1. Meet outside the works. 2.30 p.m.

THE INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the Greenwich power station of the London County Council tramways.

THE JUNIOR INSTITUTION OF ENGINEERS: NORTH-EASTERN SECTION.—Visit to the Central Telephone Exchange, Newcastle-upon-Tyne.

MONDAY, DECEMBER 18TH.

THE INSTITUTION OF AUTOMOBILE ENGINEERS: SCOTTISH CENTRE.—Royal Technical College, Glasgow. Paper, "Charging of Two-stroke Engines," by Professor W. Morgan. 7.30 p.m.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, S.W. 1. Graduates' Section (London) meeting. "Warships," by Mr. A. J. Gould. 7 p.m.

BRADFORD ENGINEERING SOCIETY.—Technical College, Bradford. Lecture, "Electric Control Gear," by Mr. O. C. Dinerman. 7.30 p.m.

TUESDAY, DECEMBER 19TH.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "Change-speed Gears on Motor Cycles," by Mr. L. J. Shorter. 7.45 p.m.

THE INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Paper, "Extensions at Tilbury Docks, 1912–1917," by Mr. F. M. G. Du-Plat-Taylor. 6 p.m.

INSTITUTE OF MARINE ENGINEERS.—85–88, The Minories, Tower Hill, E. 1. Film illustrating industrial works, Hadfields Limited. Ladies' night. 6.30 p.m.

INSTITUTE OF TRANSPORT.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment. Graduates' and Students' meeting. Lecture, "The Work of the Aire and Calder Navigation," by Mr. W. H. Breach. 5.30 p.m.

WEDNESDAY, DECEMBER 20TH.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—Chamber of Commerce, New-street, Birmingham. Meeting of Birmingham Graduates. Paper, "Some Comparative Performances of Two-stroke Engines," by Mr. A. F. Burstall. 7.30 p.m.

THE INSTITUTION OF AUTOMOBILE ENGINEERS: NORTH OF ENGLAND CENTRE.—Education Offices, Salford. Paper, "The Duty of High-tension Ignition Apparatus," by Mr. J. D. Morgan. 7.30 p.m.

ROYAL METEOROLOGICAL SOCIETY.—49, Cromwell-road, South Kensington, S.W. 7. General meeting. 5 p.m.

THURSDAY, DECEMBER 21ST.

THE POLYTECHNIC ENGINEERING SOCIETY.—309, Regent-street, W. 1. Annual conversazione. 7 p.m.

FRIDAY, DECEMBER 22ND.

THE JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Social evening. 7.30 p.m.

FRIDAY, DECEMBER 29TH.

THE JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecturette, "Brewery Engineering" (slides), by Mr. C. F. Morgan. 7.30 p.m.

CONTRACTS.—The Turbine Furnace Company, Limited, received during the month of November from eleven separate firms orders to install turbine furnaces in various types of boiler, including a four-fired marine boiler.—The Fuller Engineering Company has recently received orders for the supply of complete coal drying, pulverising, conveying—on the Fuller-Kinyon transportation system—and burning equipment from :—A coal and iron company, a chemical company, three cement companies, a coal and coke company, and two railway companies, and for a total of twenty-seven Fuller-Lehigh pulveriser mills from thirteen separate customers.—The Wellman Smith Owen Engineering Corporation, Ltd., of London and Darlaston, has secured contracts from Robert Heath and Low Moor, Limited, for steel plant, consisting of two open-hearth steel furnaces with charging platforms, Wellman mechanical gas producers, an 80-ton ladle crane, an open-hearth charging machine, a magnet crane, &c.—The Mendip Granite and Asphalte Company, Limited, has ordered from Vickers Limited additional plant for producing road material, including stone breaker, an elevator and screens, together with the steel storage bins and the necessary power installation.—The contract for supplying the fourteen sets of centrifugal pumps for the large floating dock now under construction for the London and South-Western Railway, Southampton, has been awarded to Worthington-Simpson, Limited. The approximate amount of water to be pumped during the lifting of the dock is 80,000 tons, the time of lift being 220 min.